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BULLETIN OF THE UNIVERSITY OF TEXAS, No. 5.

ISSUED SEMI-MONTHLY.

THE UNIVERSITY OF TEXAS MINERAL SURVEY BULLETIN No. 1.

JULY, 1900.

Israel C. Russell

TEXAS PETROLEUM.

BY

WILLIAM BATTLE PHILLIPS, PH. D.,

PROFESSOR OF FIELD AND ECONOMIC GEOLOGY
AND DIRECTOR OF THE SURVEY.

APPLICATION MADE FOR ENTRY IN THE POSTOFFICE AT AUSTIN AS SECOND CLASS MATTER.

ORGANIZATION OF THE SURVEY.

The University of Texas Mineral Survey was organized May 4, 1901, under the provisions of an Act of the Legislature approved March 28th. Under this act the conduct of the Survey was placed in the hands of the Board of Regents of the University, composed of T. S. Henderson, chairman, Beauregard Bryan, R. E. Cowart, G. W. Brackenridge, T. W. Gregory, H. M. Garwood, Henry B. Marsh, and F. M. Spencer.

The organization was effected May 4th by the election of William B. Phillips as Professor of Field and Economic Geology and Director of the Survey; Henry W. Harper, Adjunct Professor of Chemistry, as Chemist; Benjamin F. Hill, Fellow of Columbia University, N. Y., and formerly a member of the New York Geological Survey, as Assistant Geologist; and O. H. Palm and S. H. Worrell, Assistant Chemists. The preparation of a report on Petroleum was at once begun, data already published was arranged and new data collected in the field, and chemical work on the composition of the various Texas oils, together with determinations of their heating value as compared with coal and lignite, was taken in hand. Much work was done in the two months but there still remains a good deal to do. New wells are being bored in many parts of the State and additional facts are accumulating rapidly. If it should be found necessary a second edition of this Bulletin will be prepared during the winter.

The Bulletin is for gratuitous distribution to the citizens of the State.

LETTER OF TRANSMITTAL.

Hon. Wm. L. Prather, President, The University of Texas:

SIR: I beg to transmit, herewith, a report on Texas Petroleum, containing such reliable data concerning this industry in the State as is now available. It seemed eminently proper that the first report of the University of Texas Mineral Survey should be upon a subject which is now attracting a great deal of attention in the State and outside of it. The industrial development will depend in large measure upon the utilization of all the natural resources within its borders and it is hoped that this Bulletin will serve the purpose of attracting attention, still further, to the oil deposits which are known to exist here.

Very respectfully,

WM. B. PHILLIPS.

Austin, Texas, July 15, 1901.

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CHAPTER I.

HISTORICAL SKETCH.

Technical publications do not contain much information concerning Texas petroleum, for the reason that it was not until 1896 that the production reached as much as 1000 barrels. The attention of investigators was, therefore, not turned in this direction until about three years ago. According to official statistics collected and published by the United States Geological Survey, Division of Mineral Resources, the total production of petroleum in this State up to and including 1895, was but 361 barrels. In 1899 this rose to 669,013 barrels and in 1900 to 836,039 barrels. No State reports have been issued on the subject, inasmuch as the former geological survey lapsed in 1892, some years before the industry assumed any importance.

What is here presented has been gathered from various sources: from the publications of the United States Geological Survey; from the Mineral Industry; the Journal of the Society of Chemical Industry; the Journal of the American Chemical Society; various technical publications; from the publications of the Texas Geological Survey, wherever it touched upon the presence of oil; from friends who have kindly placed certain information at my disposal; and from personal visits to every producing district in the State.

Historical references to the presence of oil, as shown in tar springs, oil "seeps," etc., would extend back many years, possibly to the first occupation of the country by the Spaniards, and would be continued through nearly all the publications relating to this territory. It does not appear necessary to make more than a passing mention of such matters. What was said by S. H. Stowell in a report on Petroleum to the United States Geological Survey in 1883, may be taken as summing up in a few words all that could be positively stated. He said then that petroleum was known to exist in Texas, but the developments had attracted little attention and were of little commercial importance.

Between 1883 and 1886 the situation improved a little, for in that year Jos. D. Weeks, in a report to the government (Mineral Resources, 1886, page 463) said that it was reported that a natural lubricating oil, similar to that of West Virginia, though inferior, was produced in Texas. The wells which supplied it yielded about sixty barrels a day. The oil was stated to be about thirty degrees Beaume gravity, and when the wells were properly drilled and the naphtha evaporated, to make a fairly good lubricant. In this statement Mr. Weeks probably referred to the Nacogdoches field.

The oil in Nacogdoches county seems to have been discovered, so far as is known, by Emory Starr and Peyton F. Edwards about 1867.*

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*Wm. Kennedy, quoting H. H. Sawyer, 2d. An. Rep. Texas Geol. Survey, 1890.

While on a hunting expedition they dug some shallow holes on the margin of Oil Spring branch, about fifteen miles southeast of Nacogdoches, and allowed them to fill up during the night. In the morning they skimmed off the oil and carried it to Nacogdoches where it was used on harness and leather, and for other domestic purposes. Subsequently John F. Carll drilled a well four miles northeast of Oil Spring, on Caney creek, Skillern tract, and also on the Leak place, one mile west of Melrose. A little oil was found in the first well, but none in the second, at a depth of eighty feet, and the project was abandoned. Then B. F. Hitchcock began operations, being associated with E. H. Farrar, of New Orleans. The management of the company was in the hands of J. E. Pierce. An 8-inch well was drilled and oil found at seventy feet, the hole being in sand and what appeared to be drift. The first day the well flowed 250 to 300 barrels, which went to waste, and then ceased flowing and had to be pumped. This company continued to drill wells until 1889. For several years about that time there was some activity in Nacogdoches county in the vicinity of Oil Spring, and between 1887 and 1890, ninety wells were driled. One company alone, the Lubricating Oil Company, drilled forty wells on its property, and of these twenty were in operation in 1890. The wells were either pumped out or baled out, according to circumstances. In 1890 there were thirty oil wells in operation in this locality. The Petroleum Prospecting Company was organized in 1887, and up to 1890 it had drilled forty wells. Oil was found generally between seventy and one hundred feet. This company had a 3-inch pipe line, fourteen and one-half miles long, laid from its property to storage tanks built on Aaron's Hill, near Nacogdoches, and this was the first pipe line for oil in the State. The tank had a capacity of 2000 barrels. The Lubricating Oil Company shipped its oil in iron drums, holding about 100 gallons, by wagon to Nacogdoches.

Following is a section from Well No. 1, drilled on the Day farm, about eighteen miles southeast of Nacogdoches, by the Lubricating Oil Company.

SECTION OF WELL ON DAY FARM, ABOUT EIGHTEEN MILES SOUTHEAST OF NACOGDOCHES.

	Feet.
Red clayey earth	9
Bluish green calcareous shell marl	61
Dark green calcareous shell marl	49
Dark drab clay	20
Light drab clay, with pyrite	16.5
Sand and pyrite, with "slush oil"	2.5
Dark drab clay	35
Calcareous marl with sand streaks	6
Sandstone	3
Clay with sand streaks and pyrite	7
Dark bluish green shell marl	29
Dark drab clay	11
Marl	3
Total	252

The first oil was found at a depth of 158 feet.

In "Bulletin No. 4, Contributions from the Chemical Laboratory of The University of Texas," Dr. Edgar Everhart gave the results of an examination of the Nacogdoches oil, the analysis having been made by Mr. P. H. Fitzhugh. The report says:

"The oil has a brownish red color. The odor is peculiar, but not so offensive as the crude petroleum of Pennsylvania. At ordinary temperature the oil is mobile, but not so much so as ordinary petroleum. Submitted to extreme cold the oil still retains its liquidity, but naturally becomes less mobile. The temperature of the oil was reduced to less than zero (Fahrenheit) without losing its flowing qualities.

"At no temperature attainable in the laboratory by artificial means could any solid paraffin be separated. The oil does not gum on exposure to the air. It is not adapted to the production of illuminating oil; its value consists in its use as a lubricant.

"About four pounds of oil was subjected to distillation over the naked flame in a retort connected with proper condensers. The temperature was carried up to 680° F. At intervals of 45° each distillate was removed and its weight determined. The results of the distillation were as follows:

ANALYSIS OF NACOGDOCHES OIL.

	Per cent. by weight.
Below 300° F.	0.04
300° to 345° F.	0.37
345° to 390° F.	1.38
390° to 435° F.	2.09
435° to 480° F.	3.14
480° to 525° F.	6.25
525° to 615° F.	7.07
615° to 680° F.	5.63
Remaining in the retort	74.03

"A consideration of the above figures shows in the first place that the crude petroleum of Nacogdoches is practically free from naphtha, which distills off below 250° F. Four pounds of this oil carried to a temperature fifty degrees higher yielded only a few drops of a light oil, amounting to 0.04 per cent. of the total amount taken. In the Pennsylvania crude petroleum the illuminating oil comes off between 250° and 500° F., and, on an average, amounts to about fifty-five per cent. The Nacogdoches petroleum between the same degrees of temperature yields only a little over seven per cent. Three-fourths of the oil does not boil until a temperature above the boiling point of mercury is reached. Above 400° F. and even lower the distillate is not pure white, but is somewhat colored. This color deepens on exposure to the atmosphere. The distillate exhibits a beautiful fluorescence. Attempts were made to render the distillates colorless by refining them with oil of vitriol, etc., as is done with ordinary petroleum, but the results obtained were not satisfactory. Some of the crude oil was subjected to distillation until but a small residue was left in the retort. This residue had the consistency of thick pitch, and was of black color.

"The density of the petroleum at 62.6° F. is 0.9179, compared with water as unity. The density of Pennsylvania is usually about 0.794 to

0.840. The coefficient of cubical expansion, as determined by Mr. Fitzhugh, is 0.02568. Its weight, its high boiling point, its non-solidification by cold, and its property of not gumming make it a splendid lubricating material. The practical tests that have been applied to it confirm this opinion."

Interest in the Nacogdoches field, the oldest producing field in the State, has again assumed an active phase and drilling is to be resumed in the vicinity of Oil Spring and Chireno. It is proposed to carry the wells down to a much greater depth than the first ones and to attempt to secure oil from different horizons.

No statistics of the amount of oil produced in this field in the early days are now available.

In connection with the early history of prospecting for gas and oil mention may be made of the Cervanke well bored at Greenvine, in the southwestern part of Washington county, in 1879. In August of this year William Seidell bored a well to a depth of 150-160 feet and found a strong flow of gas from the sandstone. It was eleven inches in diameter and eight inches in the clear, with a wooden curbing. The gas was burned in a house near the well, but no commercial use was made of it.

Between 1879 and 1883 two or three wells were bored in the same vicinity, but they caved in so badly that it was found impossible to do anything with them. Work was suspended until 1888, when three other wells were put down, one to a depth of 154 feet, near the first well, another about 350 yards to the southeast, 134 feet deep, and the third about half a mile to the northwest, 114 feet deep. It was stated that the three new wells gave 1,500,000 cubic feet of gas per day.

This was, perhaps, the first successful attempt to secure gas in commercial quantities ever made in the State, and it is of interest to note that prospecting is again in progress in that vicinity.

This gas area appears to extend toward the east and to continue into Waller county, near Hempstead, and into the northern part of Harris county, north of Houston. It would appear that the towns in that portion of the State might enter upon the prospecting for gas with a high degree of probability of finding it in commercial quantities. The fact that a strong flow of gas was found at depths not below 200 feet would indicate that the expense of boring would not be excessive. So far as concerns its fuel qualities natural gas need fear no rival; it is easily controlled, makes a very hot fire, leaves no ashes and in conjunction with the Welsbach, or other similar mantle, gives a beautiful light.

The first appearance of Texas as an oil producer, in statistical tables, was in 1889 with forty-eight barrels, and in 1890 with fifty-four barrels. At that time the conditions in Texas were held to be similar to those in Kansas, New Mexico and Southern California. The product in 1889 was from two wells on the ranch of George Dullnig, seven miles south of San Antonio, Bexar county. These wells are about 300 feet deep and the value of their product, in 1889, was $7.08 per barrel and $4.20 in 1890. Jos. D. Weeks (Mineral Resources of the United States, 1889-90, pages 359-360) stated that this was a natural lubricant of twenty-eight to thirty degrees Beaume, and that the capital employed was $1,650, divided as follows: Value of rigs, wells, engines, boilers, etc., $1,200; value of tanks, $100; value of pipe lines, $10; value of oil in stock, $340. This oil retailed in barrels at twenty cents a gallon, in tin cans of five

TANK OF J. S. CULLINAN & CO. SABINE. CAPACITY, 37,000 BARRELS.
THE ONLY TANK IN THE BEAUMONT DISTRICT AT THE TIME OF ITS OPENING.

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gallons at thirty cents, and in less quantities than five gallons at thirty-five cents.

In 1889 some so-called "sour wells," at Sulphur Springs, Hopkins county, produced a few gallons of oil.

In 1893 Mr. Weeks summed up the situation by saying that Texas might produce a few thousand barrels of heavy gravity lubricating oil (Mineral Resources, 1893, page 463). The situation remained practically unchanged to the close of 1895, although during that year a well was drilled at Sour Lake, Hardin county, which gave some lubricating oil of sixteen degrees Beaume.

Reference should be made to the fact that in the fall of 1890 Col. Wm. L. Prather, Waco, McLennan county, while boring for water on his farm on the Bosque, a short distance from the city, found oil at a depth of 265 feet. On allowing the oil to accumulate in the well from Saturday night to Monday morning he baled out three barrels of oil, which was analyzed by Dr. Edgar Everhart, of The University of Texas, with the following results:

ANALYSIS OF OIL FROM NEAR WACO, MCLENNAN COUNTY.

Specific gravity at 78° F.	0.836
Fractions by distillation:	
Below 250° F.	0.14 per cent.
Between 250° and 400°	1.25 per cent.
Between 400° and 500°	11.67 per cent.
Between 500° and 520°	28.36 per cent.
Total below 520°	41.42 per cent.

The portion coming over towards the end of the distillation was rich in paraffin. The portion remaining in the still, amounting to about fifty-eight per cent., consisted principally of paraffin and paraffin oil.

Dr. Everhart reported, under date of October 17, 1890, that the illuminating oil given off belonged to the highest grades of such oil, characterized by high boiling and flash points.

While Waco is fifty-four miles west of south from Corsicana and is not, therefore, to be included, strictly speaking, in the Corsicana field, yet the discovery made by Col. Prather in 1890 may be said to have been the first in that part of the State. It was not until four years later that oil was found at Corsicana, but it is fair to say that this discovery gave impetus to the search for oil at Corsicana. The Waco oil has not been developed and practically nothing has been done in that immediate vicinity since 1890.

Between the period of the rise and decline of the Nacogdoches field and the opening of the Corsicana field many wells were drilled in various parts of the State and oil found in some of them. For instance, near Fort Worth, in Tarrant county, in 1887, oil was found at a depth of 240 feet; at Gatesville, Coryell county, in 1888, at a depth of 560 feet, the oil rising within forty-five feet of the surface. At New Palestine, Anderson county, in 1887, sand impregnated with oil was found at a depth of sixty feet. Time would fail us to enumerate all the localities at which small quantities of oil were obtained prior to 1895. The interest that has been developed since the coming in of the Lucas well at Beaumont, January 10, 1901, has extended to nearly all that portion of the State east of a north and south line drawn through San Antonio, and to some portions west of this line. Excluding Navarro county (the Corsicana field) and Jefferson county (the Beaumont field) there are at present more than eighty counties in which an active interest in the discovery of oil is shown. These counties lie in the Carboniferous, Sub-Carboniferous, Cretaceous, and the Tertiary. It is proposed to take these formations up in regular order and give, as briefly as possible, such information as is now to hand.

The discovery of oil in the Corsicana field seems to have been made by Major Alexander Beaton some time prior to 1894. In this year, while boring for water in the city of Corsicana, oil was found at a depth of 1027 feet. The oil was cased off and the boring continued to a depth of 2470 feet, at which depth a good flow of warm artesian water was encountered. The oil came to the surface on the outside of the casing and flowed for a year or more. An oil company was formed and a well put down 200 feet south of the artesian well, in October, 1895. It was bored to the depth of 1040 feet and reached the oil-bearing sand, which varied in thickness from ten to forty feet. This first oil well yielded two and one-half barrels a day, and in May, 1896, a second well gave twenty-two barrels. In 1896 the production was 1450 barrels from five wells, and in 1897, 65,975 barrels from forty-seven wells.

In 1897 the oil was used locally for fuel at the wells and some of it was sent to Dallas, Austin, etc., and used for making gas. A market was secured in this way, for the small output, but it was felt that any considerable development of the field would necessitate the erection of a refinery.

In 1898 Mr. J. S. Cullinan, of Washington, Penn., secured sufficient interests in the field to warrant the erection of a complete refinery with all modern improvements.* In the *Engineering and Mining Journal*, N. Y., Vol. LXV, p. 233, February 19, 1898, it was stated that there were sixty-two wells, producing on the average fourteen barrels a day, and in addition there were ten dry holes and seven wells drilling, with ten rigs in preparation. Each well had a tank of the capacity of 250 to 350 barrels, and there were two tanks of 1800 barrels capacity and one of 16,000 barrels. One tank was being erected with a capacity of 1800 barrels and another with a capacity of 30,000 barrels. The total output was then about 1000 barrels a day, with a market value of fifty cents a barrel. The expectation was to increase the output by 150 barrels a day within a short time. According to the same authority, by June, 1898, the output was 1800 barrels a day and the tanks contained 60,000 barrels of oil. At that time the area of the field was held to be two and one-half miles long by a mile wide, the longer line bearing northeast and southwest. A good deal of so-called "wild-catting" was in progress and an extensive gas field was found outside of the regular oil belt, one well developing a pressure of 200 pounds per square inch.

But little use has been made of the natural gas in the State, beyond mere local consumption at the wells. According to returns made to the United States Geological Survey, Division of Mineral Resources, the value of the natural gas produced in the State in 1889 was $1728; in 1892, $100; in 1893 and 1894, $50 each; in 1895, $20, and in 1898, $765. In the Bexar county field, south of San Antonio, good pressures have also been developed, but in no part of the State has the industry assumed commercial importance.

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*A refinery has been recently completed by the Independent Oil Co. at Powell, near Corsicana, and is now in operation, and has already shipped lubricating oil to St. Louis and other markets. The company is said to own wells producing an aggregate of 100 barrels of oil a day.

There was some improvement in the consumption of natural gas in 1899, the returns showing a value of $8,000. Considering the importance of this industry in other parts of the country it would appear that the utilization of natural gas in this State might be profitably undertaken. In 1899 the value of the natural gas produced in Pennsylvania, as measured by the amount received or value of gas consumed, was $7,926,970; in Indiana, $5,833,370, and in Ohio, $3,207,286. The total value for the entire country was $20,024,873. In this year there were 1428 companies engaged in the business, supplying 630,186 domestic fires and 4219 other establishments. The price varies from eight to twenty-five cents per thousand cubic feet.

The development of heavy gas pressures in the Beaumont field will be noticed in the discussion of this field.

The further discussion of the Corsicana field will appear in Chapter III.

As early as 1892 attempts were made to bore for oil and sulphur south of Beaumont, Jefferson county, and it is stated that Mr. Patillo Higgins, Beaumont, first began operations in the vicinity of Gladys City. He seems to have organized the Gladys City Oil, Gas and Manufacturing Company and to have succeeded in interesting capital in the enterprise. In the early part of 1892 a contract is said to have been made for the drilling of a well to a depth of 1500 feet, but that it was carried down only 300 feet and then abandoned. Mr. Higgins, who is now superintendent and geologist for the Higgins Oil and Fuel Co., Beaumont, was thus the first to endeavor to strike the oil in the Beaumont district and the first to begin actual operations there. The attempt was not successful because of the lack of knowledge, at that time, of the proper machinery and the proper means of dealing with the peculiar strata through which the drilling must progress. It is, perhaps, not too much to say that the experience obtained by A. F. Lucas in the salt districts of Louisiana was really the means of solving the problems at Beaumont. In many particulars the situation is the same and the methods of handling the quick-sand which had been found to be successful in Louisiana were applied in Texas. It is probable that if the attempts made in 1892 had been backed by practical knowledge of how to deal with the local difficulties Mr. Higgins would have been the first to strike oil in the Beaumont district.

It may be said, therefore, that while the first attempts at finding oil were made in the Beaumont district in 1892, and by Mr. Higgins, the first well came in nine years afterward and under the superintendence of A. F. Lucas. During the intervening years some attempts were made by others, but in no case was oil found in paying quantities.

The development of the Beaumont field began on the 10th of January, 1901, at which time the first Lucas well was opened, three and one-half miles south of Beaumont, Jefferson county.

Mr. A. F. Lucas is an Austrian by birth, and as a mining and mechanical engineer he has had charge of important undertakings in this country for a number of years. His experience in drilling for salt and sulphur in the lower Louisiana country stood him in good stead when he began to drill in the Beaumont field two years ago.

The three previous attempts that had been made to reach the supposed oil stratum in the vicinity of Gladys City, south of Beaumont, viz., in 1894, by Messrs. Sharp & Co., in 1896 by Mr. J. Looney, and in 1898 by Messrs. Savage Bros., had failed of their purpose. Messrs. Hamill Bros., contractors, Corsicana, began the Lucas well about the middle of October, 1900, and the oil was struck January 10, 1901, at a depth of 1120 to 1139 feet. The oil rose to a considerable height above the derrick, variously estimated at 100 to 300 feet, and came with such violence that it blew out six tons of 4-inch pipe. The upper works and heavy tackle of the derrick were carried away, and a great shower of rocks, etc., followed with the greater portion of the first flow. The first flow was estimated at 250 barrels an hour, but rapidly increased until experienced judges considered it as about 75,000 barrels a day.* It flowed at this rate for nine days and was capped January 19th. Further information respecting this well will be given in Chapter III under the heading "The Beaumont District."

The second gusher came in March 26th, having been drilled by Sturm Bros. for the Texas Western Oil Company, of which Mr. D. R. Beatty was manager. This was also a heavy producer.

The dates at which the different producing wells in the Beaumont district came in are as follows, according to the best information obtainable:

Name of Well.	Belonging to.	Came in.
Lucas	J. M. Guffey Co	January 10th.
Beatty	National Oil & Pipe Line Co.	March 26th.
McFadden No. 2	J. M. Guffey Co.	March 28th.
Gladys " 1	J. M. Guffey Co.	April 3rd.
Higgins " 1	Higgins Oil & Fuel Co.	March 25th.
Heywood " 1	Heywood Oil Co.	April 18th.
Gladys " 2	J. M. Guffey Co.	April 20th.
McFadden " 3	J. M. Guffey Co.	April 25th.
Star and Crescent	Lone Star and Crescent Oil Co.	May 1-2.
Gladys No. 3	J. M. Guffey Co.	May 3rd.
Heywood " 2	Heywood Oil Co.	May 24th.
McFadden " 4	J. M. Guffey Co.	May 26th.
Heywood " 3	Heywood Oil Co.	June 24th.
Hogg-Swayne	Hogg-Swayne Syndicate	June 27th.
Higgins No. 2	Higgins Oil & Fuel Co.	June 30th.

The exact date at which a well comes in may be subject to some differences of opinion, but the above dates are thought to be as nearly correct as they can now be made. A well may strike the oil and have to be baled before it really becomes a producer; differences of a few hours or even a day may easily arise among the drillers as to when the well really comes in.

In regard to the initial production of these wells and the rate at which they can now flow: This subject has to be approached with some hesitancy, inasmuch as no actual measurements over a considerable period

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*A. F. Lucas, "The Great Oil Well Near Beaumont, Texas," Trans. Amer. Inst. Min. Engrs., Richmond meeting, Feb., 1901.

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THE OIL LAKE AT SPINDLE TOP. BURNED MARCH 3.

have been made. Mr. Lucas stated in a paper presented to the Richmond meeting of the American Institute of Mining Engineers, February, 1901, that the Lucas well flowed at the rate of 75,000 barrels a day, estimated by those who were familiar with the flow of oil under pressure. Other statements have been made from time to time by persons more or less capable of judging such phenomena, but hardly any two have agreed. Over-estimates of such matters are very easily made and by persons who have no intention of mis-stating facts. Some have asserted that the present capacity of the wells in the Beaumont district is not less than 500,000 barrels a day, and on this basis they calculate that the yearly yield could be 182,500,000 barrels. This, of course, is a great deal of oil, being more than three times the total production of the United States in 1899, and considerably in excess of the total production of the world during that year. There are few actual facts upon which such an assertion can be predicated and it is not to be held that anything like so large an output can be reached. Just what the present capacity is we are unable to say, and we shall have to wait until accurate data can be accumulated. When the figures from pipe runs and railroad tankage are to hand it will be time enough to make positive assertions as to the capacity and the actual yield of the district. In the meantime it is better to withhold opinion. When the excitement incident to unusual phenomena has subsided and the cold record of actual measurements takes its place it will be much better for real business. We can not undertake to flood the world with oil, and if we could the prices on which many large investments have been made would suffer some remarkable changes. We have oil, there seems to be an abundance of it, and it is suitable for many purposes—therewith let us be content.

In Hardin county, at Sour Lake, oil has been known to exist for many years and at one time a little was obtained from that district. Early in June of this year the J. M. Guffey Company began to drill at Sour Lake and on the 20th inst. a gas pocket was struck at a depth of about 900 feet. A great quantity of water and mud was thrown out, with some oil, but there was not enough oil to warrant calling the well an oil well. Drilling is to be continued there and it may be that within a short time there will be some positive evidence as to the oil. Such oil as has been examined from the Sour Lake field is heavy, dark and evidently of asphaltic base. An analysis is given on page 41.

This field lies within the coastal plain and the formation does not present any marked differences from the Beaumont field. The similarity of the formation at Damond's Mound, Brazoria county, to that at Sour Lake led to the prospecting now in progress at the Mound, and the suggestion is due to the late Guy M. Bryan, a man of close observation and remarkable memory. If oil is found at the Mound it will be due to this eminent citizen of Texas, who knew the eastern part of the State well and who was always keenly alive to everything that promised to advance its interests and those of the entire commonwealth.

On July 5th oil was reported from a well at Piedras Pintas, thirty miles west of Corpus Christi, in Nueces county, but no detailed information is to hand.

CHAPTER II.

THE NATURE AND ORIGIN OF PETROLEUM.

Crude petroleum, or rock oil, is a mixture of many different substances, and to distinguish between them calls for the highest skill, both in the physical and in the chemical laboratory. While in a general way petroleums may be classified commercially by differences which are recognized with comparative ease, yet when it comes to their more scientific grouping only an experienced chemist can give an opinion.

We do not propose, at this time, to enter upon a detailed discussion of the various petroleums, for this would be out of place in a publication of this kind, but it is necessary to state certain general facts in order that a clear apprehension of the matter may be possible. From present indications it would appear that we have entered upon a new era of industrial development in Texas in which petroleum will play a most important part. A brief discussion of the nature and origin of this material will, therefore, not be out of place.

Crude petroleum may be regarded from a physical, or a chemical standpoint, or from a point of view combining these two, as it is practically impossible, in many cases, to say just where physical forces end and chemical forces begin.

As regards its physical properties petroleum may be considered from the standpoint of color, weight, odor, viscosity, and also with reference to the temperature at which it solidifies, flashes and boils.

In color it varies from colorless, as the oil from certain clays in Persia and Media, to light amber, as in certain oils from Washington county, Penn., through yellow, chestnut and brownish-black to black, some of the California oils having this color.

In weight (specific gravity), taking water as 1000, it varies from 650, as in certain oils from Koudako, Russia, to 1020, as in the oil from the Island of Zante. The range of specific gravity is, however, for the most part, between 770 and 940. A gallon of crude petroleum will vary in weight from 6.41 pounds to 7.83 pounds for the United States gallon, and from 7.70 pounds to 9.40 pounds for the Imperial gallon. Exclusive of the weight of the barrel, the forty-two gallons, ordinarily spoken of as a barrel of oil, will weigh from 269.22 pounds to 328.86 pounds, in this country.

The odor of crude petroleum may be fragrant and agreeable, as in the case of the Persian oil already mentioned, or offensive and even nauseating. The disagreeable odor of some petroleums is not necessarily due to volatile sulphur compounds, but may be due also to certain compounds of carbon and hydrogen, known as unsaturated hydrocarbons.

As regards the ease with which it flows crude petroleum may be quite mobile, as in the light colored varieties, or quite viscid, as in the black varieties. The temperature at which it becomes solid ranges from 82° F., as in oil from Burma, to several degrees below zero. The flash point (the lowest temperature at which inflammable vapors are given off) varies from below zero, as in certain oils from Italy, Sumatra, etc., to 370° F., as in oil from the Gold Coast, Africa. The ordinary range of the flash point, however, does not show such extreme limits.

By the examination of the analyses of ninety-five samples of petroleum from various parts of the world, quoted by Redwood, it is found that the flash point ranged as follows:

RANGE OF FLASH POINT IN NINETY-FIVE SAMPLES OF PETROLEUM.

In 20 samples it was below..........60 degrees F.
In 8 samples it was between........ 60 and 70 F.
In 4 samples it was between........ 70 and 80 F.
In 9 samples it was between........ 80 and 90 F.
In 4 samples it was between........ 90 and 100 F.
In 2 samples it was between........100 and 110 F.
In 4 samples it was between........110 and 120 F.
In 7 samples it was between........120 and 130 F.
In 0 samples it was between........130 and 140 F.
In 1 sample it was between........140 and 150 F.
In 2 samples it was between........150 and 160 F.
In 0 samples it was between........160 and 170 F.
In 2 samples it was between........170 and 180 F.
In 4 samples it was between........180 and 190 F.
In 2 samples it was between........190 and 200 F.
In 3 samples it was between........200 and 212 F.

There were twenty-three samples in which the flash point lay above 212° and of these there were twenty in which it lay above 240° F.

If we take the oils whose flash point lay below 60° F., we find that the specific gravity ranged from 771 to 899, the average being 838. On the other hand, the oils whose flash points were above the boiling point of water had a range of specific gravity from 921 to 1000, the average being 959. It is a remarkable fact that a Roumanian oil with a flash point of 24° F. should have had a specific gravity of 899. It is a general rule that a low specific gravity accompanies a low flash point and a high specific gravity accompanies a high flash point. In none of the samples examined, whose flash point was above the boiling point of water, was it found that the specific gravity fell below 921, the average being 959. There is a close connection between specific gravity and flash point, for the presence of the lighter oils, which are given off at a lower temperature and which are more inflammable, tends to reduce the weight of the oil as compared with water.

The boiling point of crude petroleum varies from 180° F., as with certain Pennsylvania oils, to 338° F., as with oil from Hanover, Germany.

The point at which oils become solid varies from 82° F., as with oil from Burma, to below zero, as with oil from Italy and Sumatra. This property of crude petroleum is of special value in lubrication.

From this brief account of the physical properties of crude oils it will be seen that there are many and great differences between them; and these are for the most part easily recognizable. But when it comes to the chemical nature of petroleum we find that there are still greater divergencies and that these are to be appreciated only by those who have been trained in this direction. The chemical examination of oils is one of the most difficult tasks that the practical chemist has to deal with, and it requires special and costly apparatus and unusual facilities. It is for this reason that so few, comparatively speaking, have applied themselves to this branch of analytical work.

As early as 1798 Hatchett stated that petroleum was composed, primarily, of carbon and hydrogen, with some oxygen and nitrogen, and he was of the opinion that it was not of mineral origin. From that time to the present many eminent scientists have investigated nearly all kinds of petroleum and during the last thirty years, especially, there has been accumulated a great deal of information. Perhaps the most valuable single publication is that of Boverton Redwood. It is a compendium of all kinds of data bearing on the nature and origin of petroleum, methods of utilizing it, etc. No one who wishes to inform himself on the subject can dispense with this treatise on "Petroleum and Its Products." Veith in his book (Das Erdöl) has also laid the technical world under many and lasting obligations, while among American writers may be mentioned particularly Silliman, Chandler, Orton, Peckham, Warren and Storer, Mabery and Buck, Richardson, etc.

Chemically, petroleum is a hydrocarbon, i. e., a compound of carbon and hydrogen. In addition it may contain other ingredients, as, for instance, sulphur, nitrogen, sulphuretted hydrogen, carbon bisulphide (according to one observer), arsenic and phosphorus. These other ingredients exist but sparingly, with the exception of sulphur which may rise to above two per cent.

The content of carbon varies from 79.5 per cent. to 88.7 per cent., and of hydrogen from 9.6 per cent. to 14.8 per cent. The content of sulphur varies from 0.07 per cent. to above 2.00 per cent., and in some rare cases may be even above 3.00 per cent. The nitrogen varies from 0.008 per cent. to 1.10 per cent. It is to be remarked that in some varieties of asphalt as much as 10.85 per cent. of sulphur have been found, while Kraemer and Spilker, in an article to be quoted later, mention that in the so-called "Seesclick" of the Uckermark, a substance closely resembling bitumen, as much as 3.00 per cent. of nitrogen had been found.

Crude petroleum falls either into the paraffin or into the olefin group, American petroleum, for the most part, representing the first, and Russian petroleum the second. From Pennsylvania petroleum the following paraffins have been obtained, viz.: methane, ethane, propane, butane, pentane, hexane, heptane, octane, nonane, decane, endecane, dodecane, tridecane, tetradecane, pentadecane, hexadecane, octodecane, myricyl and ceryl. This oil has also yielded a lengthy series of substances belonging to the ethylene group, such as ethylene, propylene, butylene, etc. Benzene and toluene are also present, with xylene and mesitylene.

Hydrocarbons of the olefin series occur in nearly all kinds of petroleum, but are especially characteristic of Russian petroleum, from Baku. This has yielded such members of the series as hexahydrobenzene, hexahydrotoluene, etc., and some members of the acetylene series have also been identified in it. Recently (Jour. Amer. Chem. Soc., May, 1901), Mabery has shown that the distillate from Beaumont oil, coming over between 266° and 275° F., gave hydrocarbons of the acetylene and benzene series, and the same was true of the distillate coming over between 311° and 320° F. He also found this oil to contain 2.16 per cent. of sulphur and more than 1.00 per cent. of nitrogen. The high sulphur and nitrogen content of this oil may be referred to the simultaneous action of certain diatoms and bacilli, which have the power of absorbing sulphur and nitrogen bearing compounds and giving them up to plants, as will be mentioned in another place.

With respect to the chemical nature of petroleum, there is no hard and fast line on the one side of which may be placed certain oils and on the other side certain other oils. The chemical properties shade into each other and only a general statement can be made, as for instance, that the oils from Pennsylvania fall into the paraffin series and the Russian oils into the olefin series. It may be that in the Beaumont oil we have a third class distinguished by the presence of members of the acetylene and benzene groups. Mabery remarks that the homologous series of hydrocarbons, containing but a single butyl side chain, or an equivalent in the side chains of methyl, ethyl or propyl, has been very little studied.

The following table, taken partly from Redwood and partly from Mabery, will show the chemical composition of a number of petroleums, together with the specific gravity.

COMPOSITION OF CRUDE PETROLEUM.

Description of Oil.	Chemical Composition.			Specific Gravity. Water=1.000.
	Carbon.	Hydrogen.	Oxygen.	
Heavy oil, West Virginia	83.5	13.3	3.2	0.873
Light oil, West Virginia	84.3	14.1	1.6	0.8412
Heavy oil, Pennsylvania	84.9	13.7	1.04	0.886
Light oil, Pennsylvania	82.0	14.8	3.2	0.816
Oil from Parma, Italy	84.0	13.4	1.8	0.786
Oil from Hanover, Germany	80.4	12.7	6.9	0.892
Oil from Galicia, Austria	82.2	12.1	5.7	0.870
Light oil from Baku, Russia	86.3	13.6	0.1	0.884
Heavy oil from Baku, Russia	86.6	12.3	1.1	0.938
Oil from Java	87.1	12.0	0.9	0.923
*Oil from Beaumont, Texas	86.8	12.9		0.920

*Fraction between 266° and 275° F. Fraction between 311° and 320° had nearly the same composition. Fraction between 374° and 383° had carbon 87.26 and hydrogen 12.54%.—*Mabery.*

In this connection it may be of interest to give the composition of certain coals, in order that a comparison may become possible. For this purpose analyses of Alabama coals, made several years ago by the writer, will be used. In the last edition of Poole's *The Calorific Power of Fuels* the reader will find other analyses of many different kinds of coal.

COMPOSITION OF BITUMINOUS COAL FROM ALABAMA.

Description.	Chemical Composition.—Per cent.					
	Carbon.	Hydrogen.	Oxygen.	Nitrogen.	Sulphur.	Ash.
Blue Creek, run of mine	72.34	4.45	12.35	0.89	1.06	10.16
Blue Creek, washed slack	76.04	4.48	9.64	0.79	0.85	9.05
Henry Ellen, lump	78.10	4.73	8.66	1.62	0.45	6.70
Henry Ellen, nut	77.[illegible]	4.46	9.20	1.54	0.60	7.01
Mary Lee, top	78.18	5.04	8.92	0.55	1.15	6.90
Mary Lee, bottom	78.[illegible]	5.39	9.59	0.52	1.10	7.80
Mary Lee, washed slack	75.30	5.21	5.04	1.49	0.75	11.96
Pratt, run of mine	78.98	5.01	10.96	1.19	1.16	5.92
Pratt, lump	75.[illegible]	5.46	12.29	1.08	0.98	5.79
Pratt, washed slack	78.23	4.51	9.13	1.56	1.90	5.57

As regards bituminous coal, it will be seen that it contains much less carbon and hydrogen and much more oxygen than petroleum. Anthracite coal has about the same amount of carbon as petroleum, but much less hydrogen and oxygen. There are no ultimate analyses of Indian Territory coals, used largely in this State, to hand. The writer has not been able to find any ultimate analyses of Texas coals or lignites. As this matter will be more fully discussed in the chapter dealing with the fuel value of petroleum it is not necessary to pursue it further now.

The nature of petroleum with respect to the distillates to be obtained from it will be taken up in the chapters dealing with the different Texas oils.

There are very few natural petroleums which do not have to be distilled and the distillates refined before they come into commerce. From them are made a great variety of products, such as cymogene, rhigolene, gasoline, various naphthas, kerosene, lubricating oils, paraffin wax, vaseline and numerous others.

In Russia, the products from the distillation of petroleum are grouped into many classes, viz.: light benzine, heavy benzine, safe kerosene (flash point not less than 77° F.), unsafe kerosene (flash point below 77° F.), astralin, solar oil, lubricating oils, mazoot (crude oil from which the light oils have been removed by exposure to air), astatki (residue, with a flash point not below 284° F.), solid substances, such as asphalt, ozokerite, ceresine, paraffin, vaseline, and many different greases, varnishes, etc.

While the production of petroleum in Russia is about 70,000,000 barrels a year, not more than 15,000,000 to 17,000,000 barrels are refined, the remainder going into use direct for fuel purposes. The price for Baku crude oil is now about thirty-two cents a barrel (seven copecks per pood). It has come into use on a very large scale as a fuel for manufacturing establishments, railways, river and ocean steamers, etc.

With this necessarily condensed account of the nature of petroleum we pass to a brief discussion of its origin.

THE ORIGIN OF PETROLEUM.

A great many authorities have written upon this subject and there is a considerable diversity of opinion among them. Broadly speaking, there are two views now held by those who have investigated the matter more particularly. The first is that petroleum has arisen from chemical and physical changes in inorganic material, and this has been advocated by such men as Berthelot, Humboldt, Mendeleeff, Maquenne, Byasson, Cloez, Ross, Sokoloff, Coquand, Grabowski and Hitchcock. The other view is that oil has arisen through the spontaneous distillation of animal and vegetable remains at low temperature, with or without pressure, and this is sustained by much the larger number of authorities. Among the advocates of this latter opinion may be mentioned Sterry Hunt, Lesley, Orton, Dana, Leconte, Hoefer, Wall, Newberry, Peckham, Daubree, Von Kobell, Watson Smith, Leopold von Buch, Bertels, Zincken, Paul, Tietze, Credner, Warren, Storer, Engler, Zoloziecki, Ochsenius, Sickenberger, F. C. Phillips, Redwood, White, Whitney, Binney, Hatchett (who wrote in 1798) and others.

The advocates of the theory of organic origin are further divided on the question whether petroleum is indigenous to the strata in which it is found or has arisen through what may be termed secondary decomposition, and transference from one place to another.

The theory of the inorganic origin of petroleum is receiving less and less support as the field of chemical investigation is extended, although it is not to be denied that substances closely resembling certain forms of petroleum may be produced by the action and interaction of inorganic forces. These forces are chiefly of a chemical nature and may come into play in one or more of the following ways:

PETROLEUM OF INORGANIC ORIGIN.

1. By the action of carbonic acid, or earthy carbonates, on the alkali metals at high temperature.
2. By the action of water and acids on metallic carbides.
3. By the action of steam and carbonic acid on iron or the sulphide of iron at white heat.
4. By the action of volcanic gases on limestone. In this connection it may be stated that sulphur has been obtained by the action of hot volcanic gases on chalk. Both paraffins and olefines were produced, also, with separation of sulphur and the conversion of the chalk into gypsum. Sulphur may be produced in this manner as well as by the action of sulphuretted hydrogen on sulphur dioxide and the oxidation of iron sulphide.
5. By the condensation of marsh gas.
6. By the direct union of carbon and hydrogen in the early stages of the earth's history.

Some of these hypotheses are extremely ingenious, but for the most part do not appear to be of practical importance. They may be compared with the theories as to the inorganic origin of coal. Hirshing held to the opinion that by the decomposition of limestone the carbon contained in its carbonic acid might be set free and deposited as coal or coaly material. Kleinschmidt afterwards developed the theory and calculated that a cubic mile of limestone would yield eighty-four million tons of coal, a fanciful idea, but not well supported by any known facts. The inorganic origin of coal and the inorganic origin of petroleum seem to be referable to the same line of reasoning. Many experiments have been made with a view to establishing the probable inorganic origin of petroleum and while it is evident that some of the substances obtained were closely analogous to petroleum, and that in some cases these inorganic forces may have contributed somewhat to the formation of petroleum, yet they have been entirely subsidiary to the chemical and physical forces which acted upon organic remains. It is not necessary to exclude inorganic forces from among those whose operation may give rise to petroleum, but it may be said that they are of minor importance.

PETROLEUM OF ORGANIC ORIGIN.

By far the greater weight of opinion now inclines to the view that petroleum is derived from the decomposition of animal and vegetable remains. One of the most instructive experimental proofs of the derivation of petroleum-like substances from the distillation of animal matter was made more than twelve years ago, by Engler. He distilled 1078 pounds of fish oil (from the Menhaden), commencing at a temperature of 608° F. and a pressure of 147 pounds per square inch and ending with a temperature of 752° F. and a pressure of 58.8 pounds per square inch. The distillate amounted to 60 per cent. and had a specific gravity of 0.8105, was brown in color, showed a greenish fluorescence and had a disagreeable odor, somewhat like acrolein. By fractional distillation the distillate yielded pentane, hexane, both primary and secondary heptane, primary octane and nonane, substances present in crude petroleum. *The distillate also yielded a lighting oil which could not be distinguished from kerosene.* The distillation of commercial olein gave results closely similar to the products from the fish oil and it was inferred that the fish oil was a mixture of olein, stearin and palmitin. It is worthy of note that the distillation of dried fish gave results altogether different, no products resembling petroleum having been obtained. The inference that Engler himself made was that in the process of the formation of petroleum from animal remains nitrogenous matters had been removed, only the fats yielding the oil. But some varieties of petroleum contain comparatively large amounts of nitrogenous compounds so that this view of the matter can not apply to all kinds of petroleum.

By a process of fractional distillation, with heat and pressure, or, it may be, under pressure alone, animal and vegetable remains may be converted into light oils, these in turn into heavy oils, and these into asphalt, etc. Prof. Peckham regards the oils of New York, Pennsylvania, Ohio and West Virginia as of vegetable origin, and the oils of Tennessee, Texas and California as of animal origin, and suggests a vegetable origin for such oils as have a paraffin base and an animal origin for such as have an asphalt base. Prof. Orton considers it probable that oil from shales and sandstones is of vegetable and that from limestones of an animal origin.

It may well be that the more nitrogenous oils are of animal origin, but we may refer the nitrogen content of some of them to the power possessed by certain bacilli of fixing this element. These, or other closely analogous forms of vegetable life, have also the power of (1) absorbing or (2) producing oil, together with organic sulphur compounds, as will be noted later. This is an important point in connection with certain Texas and Louisiana oils which occur in association with sulphur deposits. As a general rule the amount of sulphur found in oils from limestones is higher than in oils from shales, and this appears to hold good for Texas oils. It has an important bearing upon the oil industry, inasmuch as the sulphur-bearing oils are refined with more difficulty than oils free from this element. The amount of sulphur in crude petroleum varies within wide limits, from less than one-tenth of one per cent. to two and even three per cent.

Lesley was of the opinion that Pennsylvania oil had been formed from fossil fucoids (algæ), as well as from remains of an animal nature, such as corals, etc., and this view was also supported by Ashburner.

A. S. Cooper, State Mineralogist of California, follows pretty much along the same lines, in referring the origin of certain California oils to marine vegetation, such as fucoids and other algæ. Mention may be made of the Sargasso Sea, an area lying towards the interior of the great whirl of the Gulf Stream between the sixteenth and the thirty-eighth parallels of north latitude. The greater thickness of the algæ there is, however, between the thirtieth and fiftieth parallels. The *sargassum bacciferum* is more plentiful in this sea than any other species of gulf weed, although other varieties are present.

It is to be noticed in this connection that the largest known mass of gulf weed, coming from the temperate and south temperate zones, is now in the Sargasso Sea and reaches as far north, in latitude, as the mouth of the St. Lawrence river. May we infer that the gulf regions have been the sources of some of the petroleum, and that fucoids, diatoms and other algæ have contributed to its formation?

Among the more recent investigations which have been undertaken with a view of studying the origin of petroleum, none is more fruitful of suggestions than the work of Kraemer and Spilker. Taken in connection with the work of biologists in determining the nature of the forces concerned in the fixation of nitrogen by the roots of plants the researches of these gentlemen are of the highest interest.

In the journal of the German Chemical Society, 1899, page 2940, will be found this most important paper dealing with nature of the so-called "Seeschlick" (sea slime, ooze) found under a peat bog in the Uckermark, north of Berlin. Before giving the results of their investigations it may be said that the presence of minute drops of oil in the plasma of certain diatoms had previously been observed by Ernst Pfitzer and mention made of the fact in his book on the manner of formation and the development of the Bacillariaceae. The oil was visible under the microscope and was further identified by its optical behavior. Kraemer and Spilker took samples of peat from Franzenbad, in the northeastern part of Bohemia, and from Elster, a few miles north in Saxony, and extracted them with benzol. On evaporating the benzol they obtained a brownish-black, waxy mass in which, after cooling, there were imbedded crystals of sulphur. The amount of this waxy substance contained in the peat varied from 1.59 per cent. in the Elster to about 4 per cent. in the Franzenbad product. The content of sulphur in the wax was 10.37 per cent. for Franzenbad and 11.26 per cent. for Elster. The association of this waxy material with substances containing easily decomposable sulphur compounds (yielding crystals of sulphur upon treatment with benzol and subsequent evaporation) is a remarkable occurrence. It shows that the power of certain diatoms to secrete oil is closely allied with the power to secrete organic compounds of sulphur, the sulphur and the oil being present together. Furthermore, this power of selective absorption of oil and sulphur by these diatoms may be compared with the absorption of nitrogen and nitrogenous compounds by bacilli attached to the roots of certain plants, such as clover, peas, etc. In the case of the fixation of nitrogen by bacilli we have one of the most beautiful illustrations of the power of obscure forms of life to influence vegetable growth and even to condition it. In the case of the diatoms which absorb oil and sulphur compounds we have a fruitful suggestion of the origin of petroleum and its association with sulphur.

It may well be that the same or allied forms of life secrete nitrogen, sulphur compounds and oil, for, as will presently appear, nitrogenous compounds are found in intimate association with the oil and the sulphur. The term "absorption" has been employed, but it does not necessarily imply that the oil existed extraneous to the organism. It may have been produced by it and segregated afterwards. But whether absorbed from an outside source or created by the forces at work within the organism itself, the fact remains that the oil is present in the plasma and present, also, as a separate substance. Such oil may, therefore, be regarded as indigenous to the stratum in which it occurs and its origin is to be sought among those obscure processes of the animal organism which, so far, appear to elude more exact investigations. While it is hardly supposable that sulphur, *as such*, exists in these diatoms, yet it does exist in easily decomposable compounds, extractable by benzol and yielding crystals of sulphur upon evaporation.

An abstract of Kraemer and Spilker's article is here given for the reason that it is by far the most suggestive one that has appeared on this subject within recent years. The conditions under which many of the Texas oils seem to have arisen are similar to those which maintained in the deposition and subsequent alteration of the substance described by these investigators.

In the Uckermark, a subdivision of Prussia, north of Berlin, there exists a great deposit of a material to which the name "Seeschlick" (sea slime, ooze) has been applied. It underlies a peat bog and reaches a depth of more than forty feet. It is a grayish brown, crumbly mass, with a somewhat fatty feel in the hand. The average thickness of the deposit, over more than 2200 acres, is about twenty-three feet, and the peat covering has a thickness of about one foot.

The mass contains about ninety per cent. of water, which dries out but slowly in the air, leaving a horny mass which pulverizes with difficulty. The mass contains, when dry, more than 3.00 per cent. of nitrogen and is used for fertilizing purposes and for the extraction of ammonia on a large scale.

Under the microscope this slime is seen to consist principally of diatoms, such, for instance, as Navicularia, Melosira, Pleurosigma, etc., with fragments of Desmids, Nostoc and more highly organized plants. It is worthy of remark that some varieties of the Diatomaceae are abundant in guano, a highly nitrogenous material. Chemically they are distinguished from the Desmidiaceae by the siliceous character of their shells.

On treating the dried mass with benzol and evaporating this off there remained a dark brown, paraffin-like substance which was but little attacked by cold, fuming nitric acid. On warming the substance obtained by benzol treatment it ran together and made a waxy material which was very slowly soluble in alcohol. On crystallizing the alcoholic solution there separated out a yellowish-white, crystalline powder which melted at 75° C. (167° F.). The residue insoluble in alcohol closely resembled paraffin oil obtained from certain petroleums.

By treating the sea slime with five per cent. hydrochloric acid (by which operation about one-half of the weight was lost as hydrocarbons, organic acids, etc.) and drying the insoluble portion there was obtained, on the average, 3.6 per cent. of diatom-wax and this wax could hardly be distinguished from ozokerite. It had a black-brown color, a fatty luster, an asphalt fracture, melted between 50° and 70° C. (126° and 158° F.) and contained 0.97 per cent. of sulphur. It contained, on combustion, 73.5 per cent. of carbon and 11.2 per cent. of hydrogen, with some oxygen.

By the investigation of various specimens of ozokerite the authors found that the diatom-wax had closely similar properties and they argue for a common origin of the two. While the case may not be fully made out and while further research may modify some of the views now held there seems to be no doubt that we have here to do with an agency in the formation of both petroleum and sulphur. Messrs. Kraemer and Spilker have set forth the results of their investigations frankly and clearly, and it is to be hoped that further research will be undertaken by those qualified to deal with such matters. Commenting on the paper of Kraemer and Spilker, Mr. Clifford Richardson (Jour. Soc. Chem. Industry, Feb. 28, 1900) speaks of the presence of the remains of foraminiferae in the Texas oil sands and refers to the fact that in the Miocene shales of California (the oil horizon of the Pacific slope) there are large numbers of diatoms, and that asphalt had been detected in the shale particles.

Reference may be made to the works of A. F. Stahl and O. N. Witt, the latter of whom, in his *Prometheus*, has given in great detail the results of his investigations of the nature of diatoms. It is said that not much is known about diatoms that existed prior to the Tertiary, although it is argued that, in all probability, they flourished in ages much more remote. It is in the Tertiary, and the formation immediately preceding it, that we have in Texas the stores of lignite, sulphur and oil.

In order to investigate the matter with reference to conditions maintaining here it was decided to send an expedition to the west of the jetties that have been constructed at the mouth of the Sabine Lake where it empties into the Gulf of Mexico. For many years it has been known that there was a bed of ooze at the bottom of the Gulf along the coast of Jefferson county, and some will have it that there is an oil pond in the sea there. There is no doubt of the existence of a quiet spot in the sea to the west of the jetties, for the testimony of sailors, pilots, etc., is abundant and satisfactory. Another such quiet spot is said to lie off Padre Island and opposite the northern part of Cameron county. It is said that sailing vessels seek these spots in stormy weather and are then comparatively secure. Three expeditions that have gone to the so-called oil pond have not been able to report favorably and there seems to be lacking any positive evidence that the calmness of these spots is due to an out-flow of oil from an underground reservoir.

The expedition sent out by the Survey was for the purpose of securing samples of ooze from different localities and observing whether or no there were any indications of oil at the so-called oil pond.

The reports made are adverse to the existence of any oil at the pond, except such as manifestly has made its way down from the surface overflow at Beaumont.

The samples brought back were examined for the presence of oil-bearing diatoms and for the presence of oil and sulphur.

The reports will appear in their proper place in this chapter.

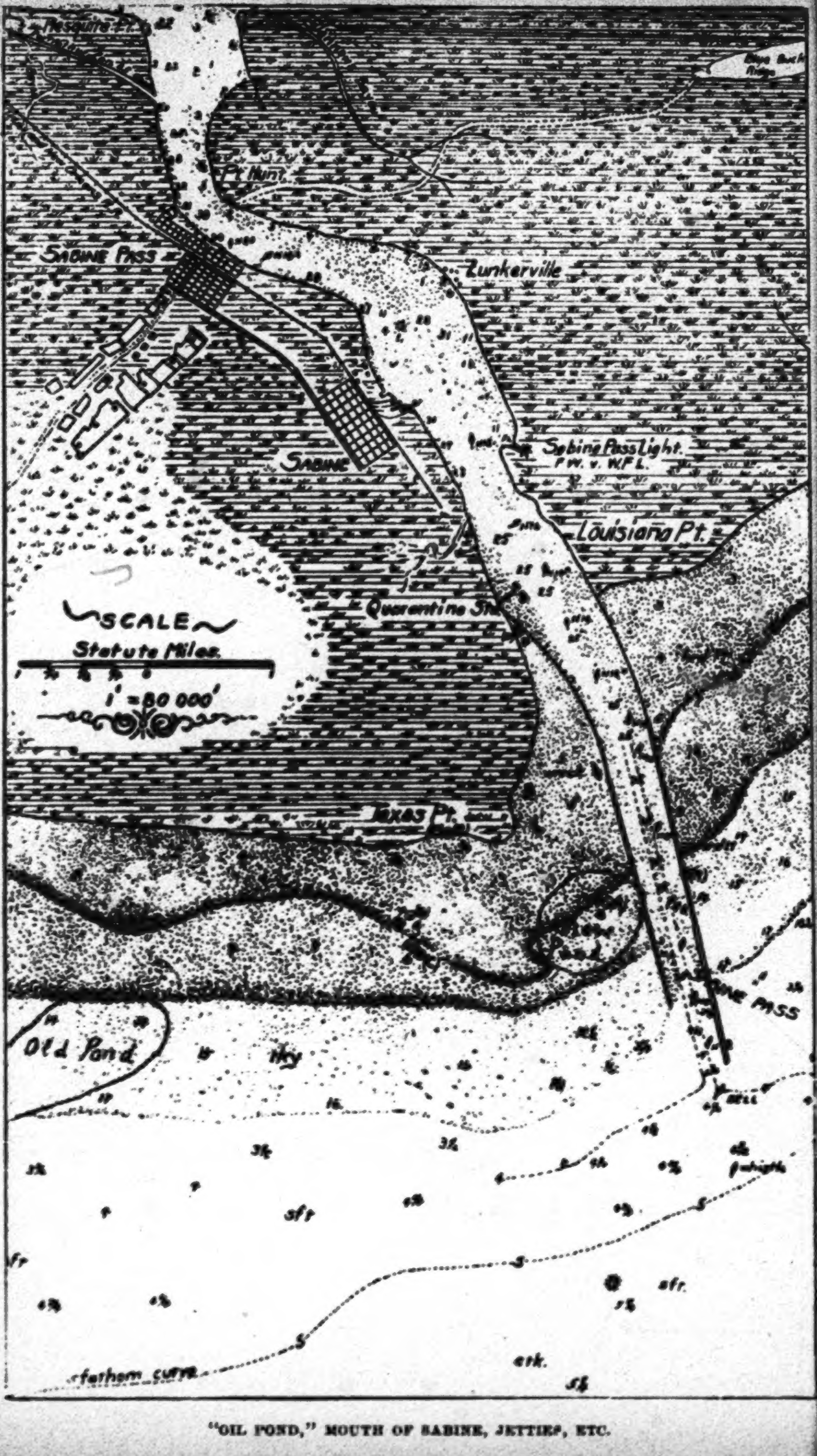
So much interest has attached to the existence of the oil pond west of the jetties that instructions were given to inquire into all the circumstances of the case and to make a personal visit to the pond in company with some one who knew the locality well. But the reports as to its existence were unfavorable and appear to confirm the opinion expressed by the writer in the *Engineering and Mining Journal*, February 9, 1901, after visiting Sabine Pass.

The question does not concern itself with whether or no there is a calm spot in the sea off the coast of Jefferson county, but whether this phenomenon is due to the presence of oil that finds its way to the surface from some underground source. Is there or is there not such an outflow of oil there? To this question a negative answer must be made in so far as concerns our present knowledge.

The true explanation of the so-called oil pond appears to be as follows: The bottom of the sea there is composed, for the most part, of a thick black mud in which are imbedded various animal and vegetable remains. Under the incipient decomposition that is nearly always in progress in such material, substances of a more or less oily nature are formed. The absorption or segregation of oil by means of certain diatoms may also have contributed to the presence of oily substances in the ooze. When this mass becomes stirred up by wave action and diffuses itself through the water, rising even to the surface, the roughness of the water is affected in a manner comparable with the action of oil. The soundings in the so-called oil pond, according to Chart No. 203 of the United States Coast and Geodetic Survey, vary from four to sixteen feet, while outside of the shallow water the depth increases to twenty and twenty-five feet, the five fathom curve lying about a mile to the south. The oil pond area is then a sort of terrace, the bottom of which is soft black mud and ooze. At one place on the chart a rocky bottom is marked, but this lies outside the area known as the pond and is between the present pond and the site of the old pond. Waves beating upon a terrace laid in material which from its very nature is more or less oily, or contains substances which would act in a manner comparable with that of oil, would seem to present the true explanation of the calmness of the area under discussion.

An examination of the map facing page 21 will show the position of the old pond and the new pond. Ten years ago the pond was much further to the west than it is now and the easterly movement seems to have been accelerated since the construction of the jetties. The so-called oil pond is not an oil pond in any sense of the term, and such oil as is now to be found in the ooze along the eastern part of the pond has come down from the surface overflow at Beaumont, through the Sabine Lake or the ship canal.

The Lucas well began to flow on the 10th of January and continued without intermission until the 19th, when it was capped. During this time it discharged a very large quantity of oil, some of which certainly made its way into Hillebrand's Bayou and so into the ship canal connecting the elevator and docks below Port Arthur with Sabine. Both before


Mesquite Pt.
Pt. Hunt.
SABINE PASS
Zunkerville
Sabine Pass Light.
F.W. v. W.F.L.
SABINE
Louisiana Pt.
Quarantine Sta.
SCALE
Statute Miles.
1' = 80 000'
Texas Pt.
Old Pond
SABINE PASS
fathom curve

"OIL POND," MOUTH OF SABINE, JETTIES, ETC.

and after the fire on the 3rd of March a great deal of oil was poured out on the ground from the Beaumont wells and considerable quantities of it have been found in the sharp angle between the shore line and the west jetty. The samples of mud and ooze obtained from this place show the presence of crude Beaumont oil, while no oil was obtained from the pond proper or from the ooze at the bottom of the pond.

The microscopical and biological examinations were made by Mr. W. H. Long, Jr., a Fellow in The University of Texas, and recently elected Professor of Natural History in the North Texas Normal Institute, Denton. The chemical examination was made by Mr. O. H. Palm, Assistant Chemist to the Survey, while the accompanying map was prepared by Mr. J. R. Johnson, a student in the Engineering Department of The University, from Chart No. 203 of the United States Coast and Geodetic Survey, published at Washington, October, 1900.

The expedition to the pond and the jetties was composed of Mr. Benjamin F. Hill, Assistant Geologist to the Survey, and Mr. Long.

Mr. Long's report is as follows:

"On May 29th four specimens, to-wit, Nos. 4, 5, 8 and 9, were obtained from the apex of the west jetty and the shore; Nos. 4 and 5 consisting of ooze from point marked *D* on the map, in a mud flat which seems to be the prolongation of the so-called oil pond.

"Specimen No. 8 was obtained from holes made in the mud and allowing the holes to fill with water, ooze and oil. Specimen No. 9 is water and surface ooze from near the point *D*.

"On May 30th specimens Nos. 1, 2, 3, 6 and 7 were obtained as follows:

"Specimen No. 1 is ooze from water six feet deep at point *A*, in the so-called oil pond. This point is about one mile from seaward terminus of west jetty and one mile from the shore line.

"Specimen No. 2 is ooze from the water four feet deep at point *B* in the so-called oil pond, and is about two and one-fourth miles from the seaward end of the west jetty and five-eighths of a mile from shore.

"Specimen No. 3 is ooze from water six feet deep at point *C* in the so-called oil pond, and this point is two miles from the seaward end of the west jetty and one mile from shore.

"Specimen No. 6 is black mud from five feet beneath the surface of the soil at point *E*, and this point is about four miles down the coast and opposite the so-called oil pond.

"Specimen No. 7 consists of mud rolled ashore by the action of the waves at point marked *E*.

"The microscopical examination of the specimens gave the following results:

"Specimen No. 1 consists of ooze from point *A* in the so-called oil pond, taken from a depth of six feet. No living animal or vegetable forms were found, but there were present many empty shells of diatoms. These shells formed only a small part of the ooze. The ooze was of a black color and seemed to be composed of thoroughly macerated organic matter, mixed with grains of silica and a number of semi-transparent globular and oblong bodies. These bodies seemed to be silica nodules in process of formation around diatom shells as a nucleus.

"Specimens Nos. 2 and 3 consisted of practically the same constituents as Specimen No. 1.

"Specimens Nos. 4 and 5 were also similar to Specimens Nos. 1, 2 and

3, but the diatom shells seemed to be more numerous and occasionally a dead diatom could be found whose shell included oil globules.

"In Specimen No. 6 the diatom shells were not so abundant, but they were of a greater variety of forms and were much broken.

"Specimen No. 7 had a few diatom shells in it and was otherwise similar to the preceding specimens.

"Specimen No. 8 contained no living diatoms and only a few diatom shells. In regard to this specimen it is to be observed that it contained a notable amount of oil which closely resembles the crude Beaumont oil and which appears to have been brought down from the Beaumont district through the bayous that empty into Sabine Lake and into the ship canal. The oil has all the characteristics of the Beaumont oil.

"There were no living diatoms in No. 8.

"Specimen No. 9, which is the water and surface ooze from near the same locality as No. 8, contains much less free oil and shows a large number of living diatoms, mainly of one species, Navicula,* with one species of Pleurosigma. Both the Navicula and the Pleurosigma contained relatively large globules of oil in their plasma. These oil globules were especially abundant in the Navicula. They were of various sizes and very irregularly distributed throughout the body of the diatom, the greater number collecting in the center and consequently around the nucleus. The oil globules in the Pleurosigma were not so abundant or so large as in the Navicula, nor did they tend to collect about the center as in the other species.

"On the death of the diatom the oil globules seem to separate from the other contents of the shell and finally to pass out of it.

"The ooze in which these diatoms were found had petroleum entangled in it and it is, therefore, possible that the oil globules seen in the diatoms were absorbed from the surrounding media. On the other hand, it is well known that oil in place of starch is one of the first products of assimilation in diatoms. It would not seem impossible that the oil globules observed in the diatoms were a direct product of assimilation, but as to this point further observation and study are needed.

"On account of the roughness of the water during the trip no surface material was collected. No oil was at any time visible on the surface of the pond. If the oil globules in the diatoms of Specimen No. 9 are the product of the vital forces of the plant and not absorbed from the surrounding medium, it is to be hoped that further study will throw some additional light upon the origin of the petroleum of the coastal plain."

EXPLANATION OF PLATE.

The drawings for this plate were made by Mr. W. H. Long, Jr., from material obtained from Specimen No. 9. Average specimens of each species were used, and each figure was drawn by the aid of an Abbé Camera Lucida to a magnification of about 900 diameters, so that the dimensions of the figure in millimeters represent, approximately, the actual size of the plant in microns. All the figures are drawn to the same scale.

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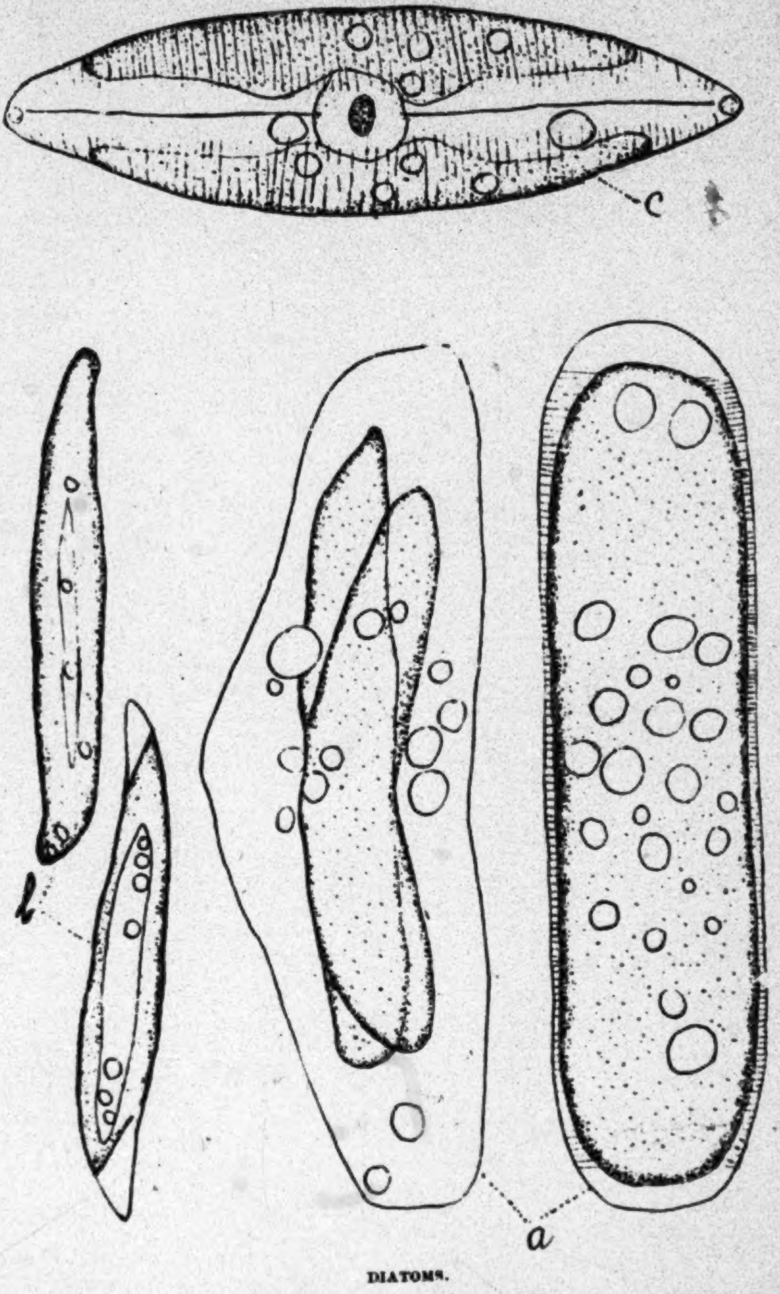
*In the American Naturalist, Vol. XXVI, pp. 505-506, Lewis Woolman and C. Henry Kain described nine forms of fresh-water Navicula, obtained from the Blanco canyon beds, Crosby county, Texas, in the Staked Plains.



DIATOMS.

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A represents a girdle, or lateral, view of a living frustule of a Navicula, showing the endochrome plates, valve markings and oil globules. The size is 145x30 microns. A_2 is the same view of a dead frustule of Navicula with its contents disintegrating and valves falling apart, but with the oil globules still present. The surface markings on the valves are not shown.

B_1 and 2 is a surface, or valve-side, view of living frustules of Pleurosigma, showing endochrome plates and oil globules. Size 75x10 microns.

C is a surface, or valve-side, view of a living frustule of Navicula, showing shape and size of endochrome plates, nucleus, oil globules, etc.

The chemical examination of the samples showed that there were only two that contained any oil, viz., Nos. 4 and 9, both these samples coming from the apex of the west jetty and the shore. Under the microscope, as already observed, Specimen No. 4 showed no living diatoms, but occasionally a dead diatom could be found whose shell included oil globules.

Specimen No. 9 under the microscope showed living diatoms which contained oil globules. Inasmuch as Nos. 4 and 9 were evidently contaminated with crude Beaumont oil, which is known to contain sulphur, they were not examined for this substance. The benzol extract of all the other samples was evaporated and allowed to cool. On cooling, sulphur separated out in the crystalline condition. The benzol extract of these specimens showed no oil. It is to be concluded, therefore, that the ooze from beneath the so-called oil pond does not contain oil, but does contain organic compounds of sulphur and that the sulphur may be crystallized out from solution in benzol.

We may have here the beginning of a deposit of sulphur or sulphur compounds not necessarily in close association with oil, but forming, possibly, a stratum above the oil and comparable in this respect to the deposits known to overlie the oil in the Beaumont field. As the ooze which contained the sulphur did not contain any living diatoms and as the oil globules in the diatoms are separated from the shell upon the death of the plant it would appear that the oil present in the diatom while living had been diffused through the water or segregated in places which were not located. The matter must be left for future investigation and there is no point in connection with the origin of petroleum and sulphur deposits which merits more attention.

Dr. A. L. Metz, Tulane University, New Orleans, examined some material obtained from the coast of Jefferson county, and communicates to us, under date of July 1st, his results.

Sample No. 1 was a specimen of asphaltum (sea-wax) from the beach due north of the oil pond. It contained:

	Per cent.
Total bitumen	98.24
Organic matter other than bitumen	1.44
Mineral matter	0.32

In this material there were no soluble salts and no free sulphur. The bitumen extracted by carbon bisulphide yielded 5.30 per cent. of a volatile inflammable oil, at a temperature of 260° F.; besides 83.27 per cent. of petrolene, 10.17 per cent. of asphaltene and 1.26 per cent. of retene. At 75° F. the material could be easily indented; at 90° F. it did not flow, but could be easily bent; at 100° F. it flowed and could be pulled into strands; at 125° F. it melted. The flash point was found to be 280° F.

Sample No. 2 was taken from the marsh north of point on the beach and between what is known on survey maps as front ridge and beach. It contained:

	Per cent.
Total bitumen	95.44
Organic matter other than bitumen	1.20
Mineral matter	3.46

In this material there were no soluble salts and no free sulphur. The bitumen extracted by carbon bisulphide yielded 64.79 per cent. of petrolene, and 35.12 per cent. of asphaltene, with a trace of retene. At ordinary temperature the material is brittle. At 150° F. it softens and is easily bent; at 180° F. it does not flow, but can be drawn into strands, which are quite brittle; at 212° F. it flows. The flash point was found to be above 300° F.

These analyses were made by Dr. Metz for Mr. G. W. Turner, President of the Oil Pond Company, and were kindly sent to us, at our request, by permission of Mr. Turner. They throw light upon the composition of this sea-wax, which has been picked up along the coast, from Sabine to Brownsville, for many years, but are disconnected from the existence of the oil pond off the coast of Jefferson county. This wax has drifted in at many localities along the coast and comes from no one knows whence.

Dr. Metz writes that he is not responsible for the statements, purporting to come from him, that these samples were obtained from the oil pond. As a matter of fact they did not come from the pond, but from the beach.

Material which was obtained by this Survey from the pond showed the entire absence of oil and the presence of organic compounds of sulphur, so easily decomposable that they yielded crystals of sulphur upon evaporation of the benzol extract. In the sea-wax Dr. Metz found an inflammable oil, but no free sulphur, or compounds which yielded it upon proper treatment.

Wax of closely similar composition may be obtained at many places in this State, as, for instance, near Greenville, Hunt county; near Burnet, Burnet county; from the asphalt deposits in Uvalde county, etc., etc. It is a derivative of petroleum, but may exist where petroleum in paying quantities does not exist.

As Mr. Long remarks, in his very interesting and suggestive report, further study will be required before we can arrive at any definite conclusion as to the part played by these diatoms in the formation of petroleum, and yet sufficient evidence is to hand to warrant the connection of these low forms of vegetable life with petroleum. In specimen No. 8 there was a good deal of crude petroleum, many shells of diatoms, but no living diatoms. In Specimen No. 9 there was some crude oil and many living diatoms which showed oil globules in the plasma. It is possible that upon the secretion of a certain amount of oil the diatom dies, or that it is not able to maintain its existence in an oil medium. It is not often that a dead diatom still containing oil can be seen, for almost immediately upon its death the two parts of the shell separate and the oil escapes. What causes the death of the diatom? It may secrete oil until it is no longer able to maintain its existence, just as the madrepores or other coral-forming animals do with respect to carbonate of lime. So far as concerns the absorption of oil from an oil-bearing medium, it is known that certain low forms of life, such as the Bacillariaceæ, Desmids, etc., contain oil globules under ordinary circumstances; they could not have absorbed it, as such, from an extraneous source. Oil is a product of certain vital functions, irrespective of the environment and whether it contains oil or not.

It is a point which can not be settled without much study and the examination of many different kinds of ooze or other material likely to be the habitat of the algæ, or analogous forms of life.

Whether we have now off the coast of Texas an oil-bearing deposit in process of formation is an open question. The conditions that might give rise to oil appear to be present and the scientific imagination may well project itself forward until the present accumulations of vegetable and animal matter, forming the thick black mud underneath the so-called oil pond and elsewhere along the coast, shall have been buried deeply and had time to yield up their oil by processes of spontaneous distillation. What is going on there now has gone on for a great many years, and present conditions, or conditions very similar to them, have marked the coastal plain since the early Tertiary. Climatic conditions have not greatly changed and the slow encroachment of the land on the sea and of the sea on the land has progressed along lines not radically different from those along which present changes are progressing. Here and there, where the conditions were most favorable, the vegetable and animal remains of the Tertiary gave rise to local oil deposits, but these deposits were not of regular extent.

The drill has shown that even in the Beaumont field there are dry holes, and we may anticipate them in other parts of the coastal plain. It is practically impossible that every hole should reveal oil in paying quantities. Just what has induced its segregation no one, perhaps, is prepared to say, but that it is segregated into deposits of greater or less extent no one can deny.

If we may connect the action of diatoms with the formation of oil deposits we would go far toward settling the origin of much of the oil of the coastal plain.

The association of sulphur and petroleum, especially throughout the area covered by the Tertiary in Texas, and also, but to much less extent, in the Cretaceous, affords another indication of the diatomaceous origin of these two substances. In the benzol extract of the peat from Elster and Franzenbad, examined by Kraemer and Spilker, sulphur crystals were observed. The forces that were active in the formation of petroleum-like bodies seem also to have effected the absorption of organic compounds of sulphur easily extractable by benzol and yielding crystals of sulphur upon evaporation. In the area covered by the coastal plain in Louisiana and Texas deposits of sulphur in association with oil have frequently been observed. In the Beaumont district crystals of sulphur have been obtained from more than one oil well and the statement is made that at least one of the wells went down through a considerable layer of this substance. For several years past attempts have been made to obtain the sulphur underlying the coastal plain in the lower part of

Louisiana, especially in Calcasieu Parish, with varying success. Some of the early operators in the Beaumont field were searching for sulphur in the hope that the quick-sand which had given so much trouble in Louisiana would be found to be of less extent in Jefferson county, Texas. Throughout the entire coastal region, extending from the Sabine river in a great curve to the Rio Grande, it is possible that the oil will be found in connection with sulphur. We know this to be the case in Jefferson, at one end of the curve, and in Starr and Zapata counties at the other end of the curve. The conditions between these points, although they are separated by 380 miles of territory, are closely similar to those which exist at the extremes. Native sulphur has been found in association with the oil of Jefferson and with the oil of Starr and Zapata. There are indication of the existence of sulphur compounds at Damond's Mound, Brazoria county, and in the Galveston deep well, at the depth of 2387 to 2410 feet iron pyrite was found, with lignite, and again between 2425 and 2432 feet. At many different depths in this well lignite was found and many other remains of an organic nature. In the first, or Lucas, oil well at Beaumont pyrite was found between 352 and 376 feet in depth, again at 563 to 588, at 718 to 785, 785 to 834, and 834 to 854. Lignite was found at 395 to 440 and 448 to 508. Sulphuretted hydrogen was found at 509 to 528. In the Beatty well, near the Lucas, sulphur was found at 940 to 980, and in the Higgins well at 1030.

Five miles southwest of Calvert, Robertson county, beds of lignite, alternating with clay, occurred to 277 feet, and the water was sulphurous. At Giddings, Lee county, a six-foot bed of lignite was found at 80 feet and a four-foot bed at 120 feet. On the Astin plantation, Robertson county, sulphur water was found at the depth of 700 feet. At Lamb's Springs, Grimes county, sulphur water was found at a depth of 547 feet. At Jefferson, Marion county, sulphur water was found at a depth of 802 feet. These instances of the occurrence of sulphur water in the area of the coastal plain are taken from a paper by J. A. Singley in the Fourth Annual Report of the Geological Survey of Texas, 1892.

Other instances might be given in illustration of the occurrence of sulphur-bearing compounds throughout the Tertiary in Texas, but these will suffice. It is not to be understood that the presence of sulphur or sulphur compounds is to be taken as an indication of the presence of oil in commercial quantities. Many wells were bored in what is now considered the oil area, i. e., the coastal plain, without coming upon any oil indications, although sulphur compounds were found. While the sulphur appears to go with the oil there are many localities where the oil does not seem to go with the sulphur, judging from the records of numerous wells. So far as is now known the oils of the coastal plain are sulphur oils and the rock with which the Beaumont oil is associated and which forms the capping over the oil, contains 1.80 per cent. of total sulphur and 1.58 per cent. of sulphur, free and in organic compounds.

The area covered by the coastal plain seems to have been formed under conditions that allowed of the formation of beds of lignite, together with pyrite and other sulphur compounds, and petroleum. Whether these have had a common origin, or whether the original substances have suffered radical changes in the course of time, only further research can determine with positiveness.

Mention may be made of the existence of sulphur deposits in Medina

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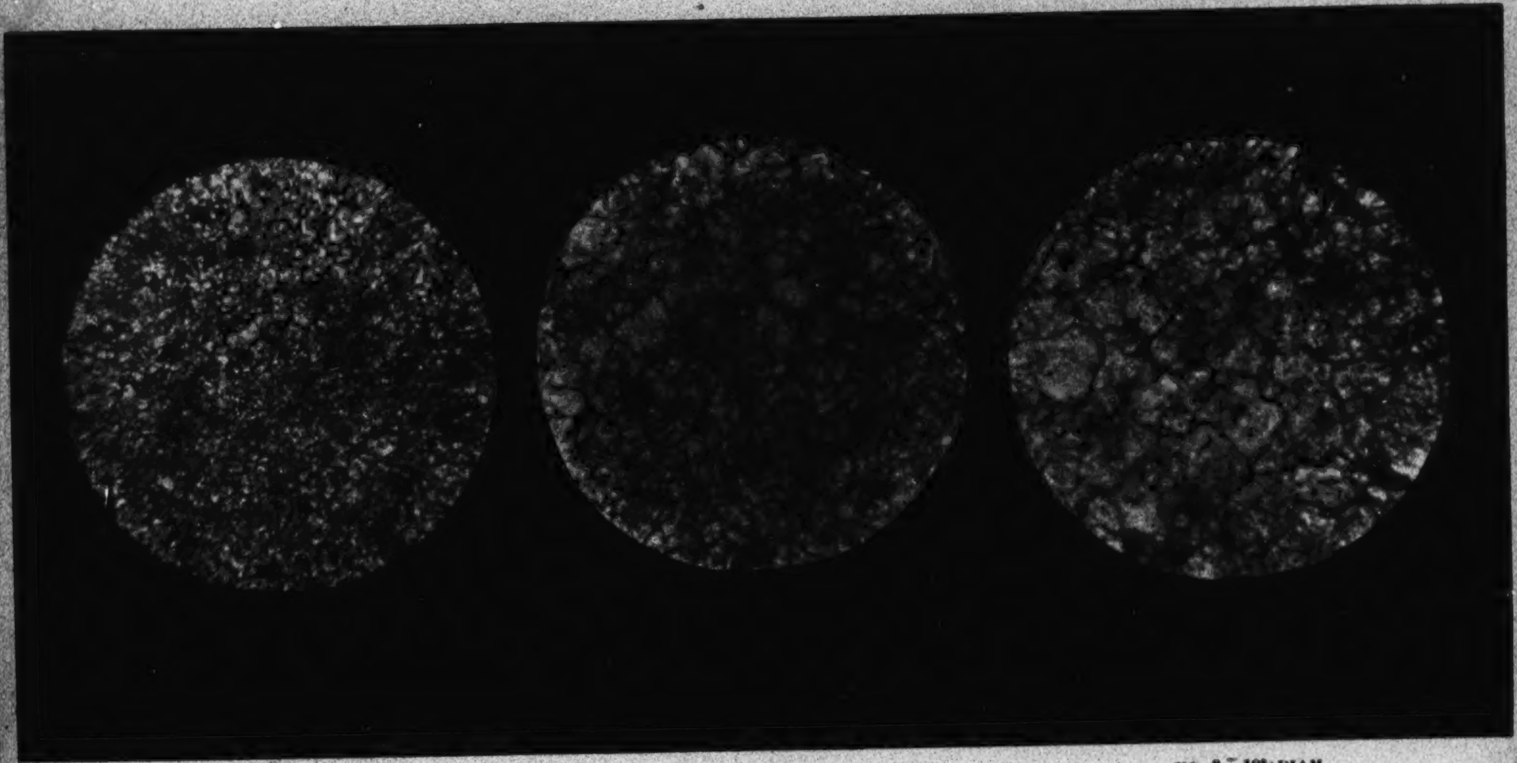

NO. 1. 15 DIAM.　NO. 2. 60 DIAM.　NO. 3. 105 DIAM.

MICROPHOTOGRAPHS OF SECTION OF THE LIMESTONE CAP-ROCK, BEAUMONT.

county, six miles south of Castroville, and within about four miles of the Southern Pacific Railway. Southwest of these deposits and at a distance of about fifteen miles is a known oil deposit, and an analysis of the oil is given on page 50 under the heading "Oil from near Dunlay, Medina county." This area is probably Cretaceous. The sulphur here is found at a depth of about forty feet, but has not been thoroughly investigated.

Well crystallized pyrite has been obtained from one of the Beaumont wells at a considerable depth, and the limestone overlaying the oil and forming the so-called "cap rock" shows crystals of sulphur. An analysis of this rock was made in the laboratory of the survey by Mr. S. H. Worrell with the following results:

ANALYSIS OF THE LIMESTONE FORMING THE CAP ROCK OF THE BEAUMONT OIL.

	Per cent.
Silica	0.40
Oxide of iron Oxide of aluminum	0.50
Lime	54.89
Magnesia	trace.
Sulphur as free sulphur and in organic combination.	1.58
Sulphur as sulphuric acid in combination	0.21
Carbonic acid	42.45

A notable feature of this rock is the presence of free sulphur and sulphur in organic combination. This tends to strengthen still further the view that in this part of the coastal plain the association between the oil and the sulphur is very close.

A piece of this rock was sent to Prof. Jas. F. Kemp, Columbia College, N. Y., for microscopical examination and the preparation of micro-photographs. Engravings are shown: No. 1, 15 diameters; No. 2, 60 diameters, and No. 3, 105 diameters. There appears to be nothing unusual in the section.

In many parts of east Texas (in the Tertiary) there are beds of lignite carrying crystals of pyrite and throughout this area generally oil has been found in small quantities. It is very common to find lignite impregnated with pyrite, and some otherwise useful deposits are rendered almost valueless from the presence of such sulphur compounds.

We have also in west Texas an instance of the association of oil and sulphur compounds. In the cienega, or marsh, that extends to the northeast of Fort Stockton, Pecos county, we have a striking illustration of the principle under discussion. According to a statement of Hon. O. W. Williams, this cienega begins about two miles from Fort Stockton and occupies an area about eight miles in length by two miles in breadth. Sulphur springs, or "seeps," are plentiful throughout this area and the upper end is within six miles of a locality where oil issues from the ground, the intervening land being of practically the same character, although not marshy. The analysis of this oil is given on page 51.

In the marsh and underneath a covering of about a foot of earth and vegetable matter is a bed of peat of a thickness of one and one-half feet, underlaid by reddish-yellow clay. At one time the peat caught fire and burned for more than a year, smouldering for the most part, but bursting into flame at intervals. There are no known deposits of sulphur in the immediate vicinity, but in El Paso county and in a formation closely similar there are extensive deposits. This locality is about 100 miles northwest from Fort Stockton, but geologically there is very little difference.

It is possible that the origin of the sulphur deposits in this part of the State is to be sought in the action of volcanic gases on limestone, whereby there would result sulphur, gypsum and various hydrocarbons. Igneous rocks are found in that part of the State, e. g., in the Davis mountains, and we may have here an instance of the action of inorganic forces in the production of sulphur and oil.

The formation of oil and of sulphur and its compounds may have gone on together and it is possible also that inorganic and organic agencies were concerned in the creation of the same deposit. There are parts of the State, e. g., the coastal plain, where the evidences of the organic origin of petroleum and sulphur are more apparent, but there are other parts where the inorganic forces may well have played a part, e. g., beyond the Pecos river, where intrusions of igneous rocks have come up through limestone. It is possible also that forces now in operation are storing up the material from which the future supplies of oil are to be obtained, just as the madrepores, millepores, etc., are constructing what may hereafter be the frame-work of continents. The activities in these obscure forms of life are difficult to distinguish and classify, and what we now observe may be the end reactions of a long series of operations visible only in their final results. The fixation of nitrogen by certain bacilli, the absorption or secretion of oil and sulphur compounds by diatoms, the building up of great structures by the coral-forming animals, are processes made manifest to us chiefly through the results. One may object that it would take an enormous stretch of time to allow of such results, but time is of no consequence in such calculations. It requires the timber growing on an acre of fairly well wooded land to make an inch of coal, and we may allow many generations of diatoms for a single pint of oil.

These suggestions are made in the hope that further research will be stimulated and additional data collected for the elucidation of the problems involved.

CHAPTER III.

OIL AND GAS-BEARING FORMATIONS.

DEVONIAN.

The Devonian, which is the great oil bearing horizon in Pennsylvania and West Virginia, is developed but sparingly in Texas, and so far as known, is not oil bearing here, at least in a commercial sense. It may be that some of the black shales lying to the west of the Coal Measures, and between these and the Permian, classed now as Sub-Carboniferous, may be found to be Devonian, and it is possible that they will produce oil in commercial quantities. This area has not been drilled over and but little is known about it.

Some of these black shales burn readily in the fire and contain both gas and oil. A notable phenomenon in connection with these shales, in the vicinity of Lampasas, is the occurrence of very hard, close-grained, black nodules, consisting of carbonate of lime with some phosphate of lime. These nodules appear to be interbedded with the black shales and closely resemble some of the phosphatic nodules from the Devonian in Tennessee. Beyond the identification of these nodules as phosphatic, which has recently been done by this Survey, they have not been thoroughly studied. It is hoped, however, to devote some time to them within the near future. Lying as they do in a position similar to that of the Tennessee phosphate, they may be taken to indicate the presence of Devonian shales instead of Sub-Carboniferous.*

Heavy black shales are developed on a large scale near the mouth of the Concho river, in the northeast part of Concho county, and near Lampasas; here they can be found in great extent, with inclusions of these phosphatic nodules.

THE SUB-CARBONIFEROUS AND CARBONIFEROUS.

According to the 2nd. An. Rep. Geol. Survey of Texas, 1890, p. 369, the counties which are in whole or in part Carboniferous, are the following: Montague, Wise, Jack, Parker, Palo Pinto, Young, Throckmorton, Stephens, Eastland, Erath, Callahan, Coleman, Brown, San Saba, Lampasas, McCulloch, Concho, Runnels, Taylor, and Shackelford. There is also some Carboniferous in Burnet county, in the vicinity of Marble Falls, and in Llano county, in Honey Creek Cove.

In this State the Carboniferous formation occupies an irregularly shaped area extending, in a general way, from the San Saba river in McCulloch and San Saba counties, in a north and northeast direction, to the Red river, the northern boundary of Montague county. Its extreme length from southwest to northeast is about 225 miles, and its greatest width, from a point south of Weatherford, Parker county, to a point east of Abilene, Taylor county, is about 100 miles. It does not maintain this width, narrowing toward the south and especially toward the north and the northeast. The total area of the Carboniferous and the Sub-Carboniferous may be taken at about 15,000 square miles, the exact extent not having been as yet determined. Within this area both oil and natural gas have been found in many places, but no commerical use has, as yet, been made of them.

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*Some of the so-called "stink-stones" mentioned in the 2nd. An. Rep. Geol. Survey of Texas, p. 401, are phosphatic.

In the 2nd. An. Rep. Geol. Survey of Texas, 1890, p. 444, there is a list of the localities where natural gas had been found within the Carboniferous area. This list is as follows:

NATURAL GAS IN THE CARBONIFEROUS.

Locality.	County.	Depth of Well in Feet.
Gordon	Palo Pinto	370
Dalton	Palo Pinto	364
Canyon	Stephens	500
Thurber	Erath	490
Trickham	Coleman	100
Waldrip	McCulloch	80
San Angelo	Tom Green	50
Belknap	Young	600
Fish Creek	Young	120

At Brownwood, Brown county, eighteen miles northeast of Trickham, oil was found in the Carboniferous shales. These shales outcrop near Lampasas, sixty miles to the southeast, at McAnnelly's Bend on the San Saba river, forty miles south of Brownwood, and at Brady, McCulloch county, about the same distance to the southwest. At Milburn, in the northeast corner of McCulloch county, oil was observed oozing from the sandstone.

At several places along the southern border of the Central Coal Field natural gas has been found, not only at Trickham, as above mentioned, but also a mile west of Trickham, where it was encountered at a depth of 280 feet. At this place the gas was ignited and burned with a flame twenty feet high. Three miles southwest of Waldrip, McCulloch county, gas and salt water were found at eighty feet, and four miles south of San Angelo, Tom Green county, gas was struck at 325 feet, coming, perhaps, from a point somewhat higher up than the total depth.

The coal that is now mined in the Carboniferous comes from the counties of Coleman, Erath, Palo Pinto, Wise and Parker.

During the last few months there has been considerable activity in the Carboniferous area. In Montague county, northwest of Dallas and Fort Worth, the oil field appears to extend from St. Jo in an easterly direction to Muenster, Cooke county. In Jack county, nine and one-half miles north of Jacksboro, and about sixty miles northwest of Fort Worth, oil has been found at a depth of 117 feet. In Palo Pinto county, near Strawn, the borings for coal have found oil, in nearly every instance at depths varying from 400 to 600 feet. Oil "seeps" have been observed on the western edge of the coal measures in Young county and natural gas has been found in three holes, varying in depth from 130 to 240 feet. In Brown county about eight years ago several wells were bored, one of them to a depth of 1950 feet, but no commercial results were obtained.

Along the western side of this area would appear to be the most favorable localities for prospecting for oil and natural gas. The presence of the one may be taken as indicative of the existence of the other, but only the drill can ascertain whether or not the oil will be found in commercial quantities. Many of the localities within the Carboniferous are now somewhat remote from rail, and the discovery of oil in commercial amounts would not be as important as the discoveries in more favored localities. Still, it is possible to pipe oil over great distances for it is not a commodity that has to await the arrival of freight trains.

In summing up the situation in the Carboniferous, including the Sub-Carboniferous, it may be said that while both oil and gas are known to exist, yet it is not known that they are of commercial importance. With the work now in progress it is fair to assume that we shall be able to make a positive statement within the next twelve months, perhaps sooner. The Montague-Cooke field is likely to show some developments within the immediate future.

As to Young county: I am informed by Mr. G. A. Graham, Graham, that the first boring near Graham was made by his brother, R. G. Graham, and himself, in 1871-72-73, to obtain salt water and gas. Following is a section of the well:

SECTION OF WELL AT GRAHAM, YOUNG COUNTY.

	Feet.
Sandy loam and earth	16
Blue sandy clay	3
Gravel and quick-sand	8
Coarse conglomerate	16
Cream colored fire clay, good quality	8
Soft sandstone, yellowish black color	10
Sandstone, similar to preceding, but harder	5
Coal, good	1
Soft sandstone, coarse and yellow	4
Hard quartzose conglomerate	13
Bluish fire clay	42
Compact hard brown clay	5
Brown sandstone, porous and gaseous	5
Clay and slate	9
Brown clay, very hard	8
Fire clay, blue and yellowish	148
Fire clay with thin stratum of shale	70
Dark brown shale, very hard, increase of gas	8.5
Hard red shale, increase of gas	10
Bluish sandstone, increase of gas	1.5
	391

The first gas was struck at a depth of 371 feet, and there was a steady increase for the ensuing twenty feet.

Several years ago while digging a well near St. Jo, a deposit of almost pure asphalt was reported at a depth of thirty-five feet, but as the men were in search of water and did not care especially for asphalt, the well was filled up. Samples of the asphalt obtained from near St. Jo have been sent to the Survey, in addition to the samples of asphalt rock. They are of good quality. The area over which the asphalt rock is found is said to be about twelve miles wide, and of unknown extent toward the northwest, St. Jo occupying about the middle of the deposit at its lower or southeast end.

The existence of asphalt in Montague and Cooke counties has been known for some years, but the field has been little explored. Its nearness to cities and towns in that part of the State would seem to offer very favorable opportunities for using it as a paving material, and this has been done to some extent in St. Jo, with good results.

In the latter part of April of this year, gas and oil were struck in a well a mile north of Muenster. The oil was first found at a depth of 100 feet, but was largely of an asphaltic nature, being black and somewhat thick. What the developments will be in depth remains to be seen. The Montague-Cooke field is worthy of further investigation, and the results of work now in progress will be awaited with a great deal of interest.

The field lies between the Carboniferous and the Cretaceous, with no very clearly defined limits as yet. Even where the Cretaceous shows on the surface it is possible that the drill will penetrate the Coal Measures in depth, or possibly the Devonian. The Carboniferous formation in that part of the State is considerably narrower than is the case farther toward the southwest, and the connection of the Montague-Cooke field with the uplift near Graham may lead to a closer knowledge of the commercial possibilities with respect to asphalt, oil and gas.

In a well bored twenty-five miles west of Graham, on Young county school land, gas was found at 175 feet, and again at 364. There are 300 feet of salt water in the well and at times it is forced out by the gas, which, on ignition, burns with a flame twenty feet high. No oil was found in this well, although some has been found in neighboring wells. Another well, 175 feet deep, nineteen miles southwest from Graham, had a strong flow of gas, but is now caved in.

The Falls at Graham appear to be the dividing line between the salt water and the fresh, the former being below the Falls. The dip of the rocks is about twenty-five feet per mile west and northwest, but at the uplift, a mile north of Graham, the dip increases to forty-five and even to sixty degrees.

Along the uplift, which extends northeast and southwest of Graham for a total distance of about forty miles, there are indications of both gas and oil, and it is probable that in this region systematic prospecting would reveal either gas or oil, or both, in commercial quantities.

An extension of this line for sixty miles to the northeast would bring one to the vicinity of St. Jo, Montague county, and Muenster, Cooke county, where the indications for both gas and oil are of an encouraging nature.

St. Jo is on the eastern edge of Montague county and Muenster is about twelve miles southeast of St. Jo. They lie a little east of the line of the Carboniferous, the Cretaceous impinging somewhat upon it here. In the vicinity of St. Jo there are extensive deposits of asphalt rock, samples of which showed the following composition in the laboratory of this Survey:

ANALYSES OF ASPHALT ROCKS FROM NEAR ST. JO, MONTAGUE COUNTY.

	Per cent.			
	1	2	3	4
Petrolene	5.31	7.00	8.8	1.9
Asphaltene	0.45	3.60	1.2	0.2
Carbonate of lime	0.56	trace	3.0	28.1
Insoluble siliceous matter	93.68	89.20	87.0	69.8

These would show, in total bitumen, 5.76, 10.60, 10.0 and 2.1 per cent., respectively.

Samples from Uvalde county (Cretaceous) gave:

	Per cent.				
	1	2	3	4	5
Petrolene	5.12	6.07	5.45	7.13	9.28
Asphaltene	5.08	5.31	3.31	7.68	6.73
Carbonate of lime	7.69	85.44	14.80	84.91	78.73
Insoluble siliceous matter	82.11	3.18	76.44	0.28	5.26

These would show, in total bitumen, 10.20, 11.38, 8.76, 14.81 and 16.01 per cent., respectively.

Samples from Burnet county (Carboniferous [?]) gave:

	Per cent.	
Petrolene	6.75	8.4
Asphaltene	7.76	1.9
Carbonate of lime	81.33	88.2
Insoluble siliceous matter	4.16	1.5

These would show, in total bitumen, 14.51 and 10.3 per cent., respectively.

In connection with the heavy black oil shales of the Carboniferous and Sub-Carboniferous, it may be of interest to state that the oil-shale industry in Scotland is still carried on. The production of oil-shale in 1898 was 2,133,409 tons, valued at $2,592,090. It is said that a ton of this bituminous shale affords very nearly a barrel of petroleum distillate, and that this has about the value of a barrel of American crude oil laid down in Scotland. From each ton of the shale there is likewise obtained about fifty pounds of sulphate of ammonia, worth about $2.50 per hundred pounds.

From 100 gallons of the crude shale oil there are obtained thirty gallons of fair illuminating oil, sixteen gallons of heavy oil, fourteen gallons of paraffin scale, eight gallons of lighter oils, and five gallons of petroleum spirit, besides coke and tar suitable for fuel. So far as at present known there are no analyses of the oil shales of Texas available, but it would appear that an industry which paid from fifteen to twenty per cent. during the year 1898 in Scotland, might not be incapable of exploitation here.

ANALYSIS OF OIL FROM JACK COUNTY.

A. L. METZ, Tulane University, N. O.

CERTIFICATE OF ANALYSIS

"Of a sample of crude petroleum received of the Sabine Oil and Mineral Co. through Mr. Wm. Jordan and reported by him as having been taken from land in Jack county, Texas, about eight (8) miles from Jacksboro station on land belonging to the Sabine Oil and Mineral Co.

Physical Appearance.—The oil has a brownish-black color, is heavy, having a specific gravity of 0.921. The boiling point of the crude oil is 137° Cent. (278.6° Fahr.).

RESULTS OF FRACTIONAL DISTILLATION WITH SPECIAL PRECAUTIONS AGAINST "CRACKING."

Fraction.		Temperature, degrees C.	Per cent. by volume.	Specific Gravity.	Color and Remarks.
Illuminating Oils, 18.41%	1	Below 150 (302° F.)	0.80		Colorless.
	2	150:200 (302° to 392° F.)	2.08	0.800	Light straw, flashes 53.50 (129° F.).
	3	200:250 (392° to 482° F.)	1.42	0.840	Light straw.
	4	250:300 (482° to 572° F.)	14.11	0.845	Yellow flashes 102° (215.6° F).
Lubricating Oils, [illegible]	5	300:572° F.	5.80	0.845	Yellow flashes.
	6	Receiver changed	22.27	0.850	Reddish yellow 180.0 (356° F.).
	7	Receiver changed	30.23	0.855	Darker than the above, flashes 220° (414° F).
	8		11.11	0.880	Red. Flash, not taken.
Residue.		Asphalt with some coke.	12.[illegible]		
			100.00		

The analysis of the crude petroleum indicates that the greater portion of the oil is composed of hydrocarbons which are well suited for lubricating purposes. The crude oil contains sulphur compounds, the amount of sulphur present in the oil as it was received being 1.42 per cent.

Grit in oil	0.99
Water	2.25
Asphaltum	13.64

A portion of the distillate obtained from the direct distillation of the crude oil was subjected to a second distillation, the apparatus so arranged as to facilitate "cracking" with the following results:

Fraction.		Temperature, degrees C.	Per cent. by volume.	Specific Gravity.	Color.
Illuminating Oils, 57.705.	1........	Below 150 (302° F.)	4.44	0.790	Colorless.
	2........	150—200 (212° to 392° F.)	3.28	....	Colorless.
	3........	200—250 (392° to 482° F.)	11.21	0.850	Light yellow.
	4........	250—275 (482° to 527° F.)	22.12	0.860	Yellow.
	5........	275—300 (527° to 572° F.)	16.66	0.866	Yellow.
		Over 300-572° F.	31.11	————	Red.
		Residium........	11.18		
			100.00		

By the process of "cracking" the amount of illuminating oils have been very materially increased and the quantity of lubricating oils diminished. The "cracking" of this oil was accomplished by direct fire and the apparatus so arragned that the condensed portions of the oil fell back into the retort, thereby coming in contact with a higher heat and splitting into lighter hydrocarbons. Solid paraffin was not found in the crude oil or in any of the refined products. The refined products were submitted to a low degree of cold without congealing.

The mineral constitutents, after freeing the crude oil from grit, amounted to an insignificant trace."

In the United States the production of shale oil has long since passed away, owing to the greater cheapness with which natural petroleum is obtained. The interest that may attach to the Texas oil shales must, therefore, be considered not very immediate.

The exploitation of the Sub-Carboniferous and Carboniferous area will naturally follow along the lines of oil and natural gas, and the indications are, in many places, sufficiently encouraging to warrant more extensive prospecting.

CRETACEOUS.

The next oil horizon above the Sub-Carboniferous and Carboniferous is the Cretaceous. This occupies a very large area in Texas, probably in excess of 100,000 square miles. Its northern boundary is the Red river from a point west of the Arkansas-Indian Territory line, to Cooke county. It forms a great belt across the State in a general southerly and southwesterly direction, with the Tertiary on the east and the Carboniferous and Silurian on the west. The eastern boundary passes near Corsicana, Navarro county; Cameron, Milam county; Elgin, Bastrop county; Lockhart, Caldwell county; Seguin, Guadalupe county; Pearsall, Frio county; and comes to the Rio Grande at Laredo, Webb county. Northwest of Laredo there is Tertiary (Eagle Pass coal field) in Dimmit and Maverick counties. San Antonio, Bexar county, is well within the area. It then turns toward the northwest into the region drained by the Pecos river, and extends up to and into New Mexico. The quicksilver deposits in the southern part of Brewster county are in the Cretaceous, as also the sulphur deposits in the northwestern part of El Paso county, south of Delaware Creek, and the oil deposits in Pecos county, northeast of Fort Stockton.

The Corsicana, Bexar county, and Medina county, oil districts, are in this formation, and, with the exception of the oil produced at Nacogdoches and Sour Lake, it furnished practically all of the oil obtained in Texas up to the opening of the Beaumont field. The oil from the Cretaceous varies somewhat in quality. Heavy oils and light oils are found at Corsicana; the Bexar county oils, so far as known, are not so good for the manufacture of illuminating oils as some of the Corsicana oils, although excellent for lubricating purposes, while the Medina county oil carries as much as 32.60 per cent. of illuminating oil. The sample of Pecos county oil was obtained from a "seep" and can not, therefore, be compared with the others. By far the greater quantity of the oil so far obtained from the Cretaceous is suitable for the production of illuminating oil, and we may anticipate that this formation will be found to be the main source of such oil.

The Cretaceous is not known to be oil bearing, in a commercial sense, in more than a few localities and these somewhat widely separated.

The producing wells in the Corsicana field occupy a somewhat restricted area, but in Bexar county the Dullnig, Walsh, and Sutherland wells, are at distances varying from three to twenty miles from each other, and it is thirty miles across to the Medina county well. From the Corsicana to the Bexar county field is 225 miles, and there are no producing wells between. North and northeast of Corsicana there are no producing wells; so that from the Red river to the Rio Grande, a distance of 370 miles, there are three areas known to be oil bearing in a commercial sense, Navarro county (Corsicana), Bexar county, and Medina county. Travis county, north of Austin, might be included, although the oil found on Walnut Creek is more like asphalt than oil, coming from a depth of about forty feet.

A brief sketch of the historical development of the Corsicana field was given in Chapter I.

THE CORSICANA FIELD.

This occupies an area of twelve to fifteen square miles near Corsicana, Navarro county, having an elliptical shape with the longer axis extending northeast and southwest about six miles. The oil "sand" is found at a depth of about 1050 feet, and is soft gray shale, highly siliceous, containing various foraminifera, such as Globigerina, Rotalia and Nomionina. Some of these correspond closely to the forms present in the oil sands and in the chalk beds of Europe. The drilling in the Corsicana field proceeds, at times, with great rapidity, owing to the comparatively soft material, sand, clay, etc., overlaying the oil "sand," a record of 1000 feet in thirty-two hours having been made by Mr. Ben Harper.

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*Good lubricating oil has been produced from wells drilled in the Cretaceous in Bastrop and Caldwell counties. Three wells near Elgin, in the former county, and three near Lockhart, in the latter, have been drilled to a depth of between 300-400 feet and an excellent heavy oil encountered. Deep wells will be sunk in an attempt to strike stronger flows.

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The ponderosa (Exogyra ponderosa) marl characterizes the field, and as the elevation is 427† feet above tide, the bottom of the holes is about 575 feet below sea level. The oil sand appears to be regular in formation and to dip toward the southeast about fifty-three feet to the mile. The bottom of a 1050-foot hole at Corsicana would be about 375 feet above the bottom of a 1050-foot hole in the Beaumont field.

The existence of the oil-bearing sand in depth between Corsicana and Beaumont can be proved only by borings, and it is idle to suppose that oil exists in paying quantities over this large area. The Nacogdoches field is in a different formation, and the wells put down in the Oil Spring and Chireno neighborhood have drawn their oil, not from the Cretaceous, but from the Tertiary. If the Cretaceous extends underneath the coastal plain none of the Beaumont wells have reached it, for not a single Cretaceous shell has yet been brought up, although Tertiary shells have been found. The 3000-foot well at Galveston did not reach the Cretaceous. The Cretaceous *may* extend under the coastal plain as a uniform sheet; it may be present at some localities and absent from others, but we do not know. The cap-rock of the Beaumont oil is an almost pure limestone containing less than a half of one per cent. of silica, with crystals of native sulphur, phenomena wholly lacking in the Corsicana field. The connection between these two fields appears to be entirely fanciful; the geological formations are different, the oil rocks are different, and the oils themselves are different.

Upon striking the oil "sand" at Corsicana there is generally a considerable delay before the oil appears, sometimes as much as twenty-four hours. Some of the wells have been "gushers," the oil rising to a height of 100 feet, forced out by gas pressure. The oil will flow for five to ten minutes and then cease flowing for a short time. The intensity of the flow is greatest between 4 p. m. and midnight, and then diminishes until about 9 a. m.

Gas pressures up to 200 pounds per square inch have been observed. Northeast of Corsicana, near Chatfield, a strong flow of gas was found at 862 feet. A mile south of Corsicana another strong flow was found at 1040 feet, and another three miles southwest. The gas area may be quite extensive, as a strong flow has been found seventy-five miles south of Corsicana, in Robertson county, near the town of Hearne. A limited use is made of it.

Since the discovery of oil at Corsicana the development has been steady and thorough. The limits of the field have been increased by a very complete system of test wells and it is now about six and one-half miles long by two to three miles wide. In the productive field, however, are several belts that are practically dry, as the drillings show that the oil sand has thinned and pinched out, in some places being absent entirely. The heaviest wells, that is, the ones producing the most oil, are generally located where the sand is thickest, but there are exceptions, one forty barrel well tapping the sand where it is only a few feet thick.

Drilling in this field has gotten to be almost an exact science, and very few accidents occur. Though the variation in the depth of the wells may be about 200 feet, it is largely due to the height of the ground upon which the rig is set. Slight dips and pitches occur in the formations penetrated, but they are well understood, and the depth to which it is necessary to go can be determined to a great degree of accuracy by the experienced driller. The methods employed in drilling are with the usual rotary and cable rig type in about equal numbers. It seems, however, that most of the large companies are using the cable rig, which, although more expensive, gives on the whole a better well. Great care is necessary in the manipulation of the casing. The flows are small and it is necessary to go to just the proper depth in the oil sand to get the best results. Below the oil horizon the sand is generally filled with salt water. But two sizes of casing are used in the ordinary well. The well is begun with a six inch and finished with a four and five-eighths inch. When the wells become dry the casing is easily removed. The average cost of a completed well in the Corsicana field is about $1000, which is from one-fourth to one-tenth of the cost in the Beaumont field. While the Beaumont field is somewhat more difficult to drill in, the cost as compared with that of the Corsicana field is out of all proportion.

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†H. & T. C. R. R crossing.

There are two systems of pumping in vogue, the rod system and the compressed air system. Gas engines utilizing the natural gas from the wells are extensively employed. Small producers having only a few wells have their pumping done by contract at a stated price per month. The oil is pumped into wooden tanks of a 100 barrels capacity located at convenient points in the field. The tanks are gauged and are connected with the refinery by an extensive system of pipe lines. A very complete and convenient system of measuring and handling the oil has been devised. The royalties in this field, which range from one-eighth to one-tenth, are paid to the land owner by the refiner.

The oil is pumped from the well tanks by engines at a central pumping station. From this station it goes to the large storage tanks that supply the refinery. There are about twenty-five of the standard 37,000 barrel tanks in use. In the field there is 100 miles of pipe lines, ranging in size from three to six inches, with the greater part, however, being two and three. The natural gas in the region is utilized to a small extent for fuel and lights in the town of Corsicana, and a system of mains has been constructed for its distribution.

The Corsicana refinery has a capacity of 1500 barrels crude oil per day. Half of the output consists of the gasoline and kerosene of various grades, while the residuum is marketed for fuel. A large proportion of the illuminating oil used in Texas and the neighboring States is the product of the Corsicana refinery. About $1,000,000 is invested in this refining plant.

In the United States, generally, 100 gallons of crude oil yield seventy-six gallons of illuminating oil, eleven gallons of gasoline, benzine and naphtha, three gallons of lubricating oil and ten gallons of residuum and loss. (Oliphant.)

During the first three months of the current year there were forty-two new oil wells drilled in the Corsicana field, twenty-five of which were producers. In the same period fourteen gas wells were drilled, nine of which were producers. The development has been somewhat retarded by the falling price of the crude oil, which decline has been brought about by the discovery of the Beaumont field. On the first of May, 1900, light crude oil from Corsicana was worth $1.10 per barrel of forty-two gallons at the refinery. On May 1, 1901, it was worth seventy-eight cents, and at the present time (July) the price is about seventy cents. The price of the heavy crude fell from sixty cents on January 1, 1901, to twenty-five cents on the 30th of the same month. Up to the first of May of the current year 1060 wells have been finished in the Corsicana field, and of these 600 are now producing oil, the output per well ranging from one to thirty barrels per day. The general average is about five barrels a day, thus giving a total output for the field of about 3000 barrels per day. The strongest well in the field was less than fifty barrels per day. The life of a well is uncertain; some have been producing steadily for five years, while others may become dry in less than a year. Since the opening of the field there has been a very perceptible diminution in the pressure, and in each succeeding year the proportion of dry wells becomes larger. The field, however, is by no means exhausted, and with satisfactory prices large quantities of oil will continue to be produced.*

The report from the Corsicana field for the month of June shows: Wells completed, 4; producing, 4; gas, none; dry, none; abandoned, 2; drilling, 3; rigs, 3. Total to July 1st: completed, 1068; producing, 603; gas, 23; dry, 229; abandoned, 213.

WALTON FARM WELL NO. 2. DRILLED BY THE SOUTHERN OIL CO.
CORSICANA FIELD.

From	To	Made Ft.	Formation.	From	To	Made Ft.	Formation.
Surface	6	6	Soil.	192	259	67	Gray marl.
6	44	38	Yellow clay.	259	1039	780	Blue marl with streaks of soft gray shale.
44	87	43	Black "gumbo" (clay).	1039	......	....	Gray oil sand.
87	98	11	Yellow clay.				
98	140	42	Green sand.				
140	162	22	Clay and "gumbo" (clay).			1039	
162	192	30	Dark mud and marl.				

COUNTY POOR FARM WELL NO. 2. DRILLED BY THE SOUTHERN OIL CO.
CORSICANA FIELD.

From	To	Made Ft.	Formation.	From	To	Made Ft.	Formation.
Surface	8	8	Soil.	920	923	3	Gray shale with some gas.
8	52	44	Yellow clay.				
52	56	4	White sand.	923	931	8	Gray shale with streaks of gray sand.
56	62	6	Soft shale and yellowish white sand.	931	1068	137	Gray marl.
62	97	35	Muddy dark colored marl.	1068	1080	12	Blue marl.
				1080	1083	3	Little streaks of gray sand.
97	106	9	Yellowish clay.				
106	129	23	Green sand.	1083	1088	5	Sand with salt water and show of oil.
129	165	36	Black "gumbo" (clay).				
165	181	16	Streaks of yellow clay and "gumbo" (clay).	1088	1190	102	Salt water sand.
181	198	17	Dark marl running into blue.				
198	920	722	Blue marl.			1190	

This well was not a producer.

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*Of the heavy oil, the total production for the State of Texas for 1900 was 6479 barrels, the total value of which was $4,277, giving an average of 66 cents per barrel. The oil was from the Powell field, Corsicana; from the Dullnig well, Bexar county, and from Nacogdoches, but most of the oil was from the Powell field. This field was opened up about September 1, and produced a heavy fuel oil selling for 60 cents per barrel. The oil from Nacogdoches was $5.00, while that from Dullnig's was a little more.

PRESLEY WELL NO. 2 (TOWN LOT). DRILLED BY SOUTHERN OIL CO. CORSICANA FIELD.

From	To	Made Ft.	Formation.	From	To	Made Ft.	Formation.
Surface	7	7	Soil.	178	618	440	Dark colored marl, running into blue.
7	48	41	Yellow clay.	618	902	284	Gray marl, hard and soft streaks.
48	57	9	White sand, intermixed with clay.	902	933	31	Blue and gray marl.
57	65	8	Black muddy marl.	933	990	57	Blue marl.
65	94	29	Yellow clay with streaks of marl.	990	1025	35	Oil producing sand.
94	101	7	"Gumbo" (black waxy clay).				
101	110	9	Marl and sand.			1025	
110	167	57	Black "gumbo" (clay).				
167	178	11	Streaks of clay and black "gumbo" (clay).				

The following tables, taken from the publications of the United States Geological Survey, show the development of the Corsicana oil field:

WELL RECORD AND PRODUCTION OF CRUDE PETROLEUM IN THE CORSICANA FIELD IN 1898, BY MONTHS.

Month.	Wells.						Rigs.	Production in barrels of 42 gallons. b
	Completed.	Producing	Dry. a	Drilling.	Gas.	Abandoned.		
January c	76	65	10	6	....	....	8	13,797
February	11	9	2	19	....	1	18	20,110
March	25	23	2	17	1	....	17	21,421
April	22	20	3	6	....	....	13	30,270
May	22	21	1	13	....	1	7	31,607
June	26	24	2	8	1	....	20	55,677
July	24	24	....	18	....	....	9	50,649
August	30	29	1	11	1	....	11	58,458
September	29	28	1	14	....	....	18	63,138
October	27	23	4	16	....	3	7	62,257
November	24	23	1	12	1	....	8	64,777
December	27	22	5	14	....	2	4	67,083
Total	374	342	32	13	4	7	11 d	544,620

a Includes two artesian wells. b Includes local consumption approximated. c One-half month estimated and covers all previous operations. d Average.

WELL RECORD AND PRODUCTION OF CRUDE PETROLEUM IN THE CORSICANA FIELD IN 1899, BY MONTHS.

Month.	Wells.						Rigs.	Production in barrels of 42 gallons. b
	Completed.	Producing	Dry. a	Drilling.	Gas.	Abandoned.		
January	19	14	5	12	....	2	6	63,975
February	15	12	2	9	....	4	8	50,755
March	21	16	4	9	1	4	5	64,047
April	13	8	5	16	....	2	9	62,928
May	29	11	16	17	2	1	10	57,627
June	29	18	10	14	1	1	9	[illegible]
July	22	12	10	9	....	3	11	[illegible]
August	22	9	11	15	2	14	11	53,544
September	23	16	6	15	1	17	10	[illegible]
October	27	22	5	11	....	11	7	[illegible]
November	24	16	7	12	1	8	6	[illegible]
December	23	14	9	15	....	12	3	[illegible]
Total	268	169	90	13 c	9	79	8 c	[illegible]

a Includes two artesian wells. b Local consumption estimated. c Average.

WELL RECORD AND PRODUCTION OF THE CORSICANA OIL FIELD FOR 1900, BY MONTHS.

Month.	Wells.						Rigs.	Production in barrels of 42 gallons. b
	Completed.	Producing	Dry. a	Drilling.	Gas.	Abandoned.		
January	29	23	4	12	1	7	2	[illegible]
February	31	24	5	8	2	16	6	[illegible]
March	35	29	6	13	....	16	4	[illegible]
April	28	18	10	15	....	9	4	[illegible]
May	36	21	11	9	4	12	5	[illegible]
June	25	19	4	16	3	9	6	[illegible]
July	35	29	9	14	....	5	14	[illegible]
August	37	23	14	20	....	11	4	[illegible]
September	41	25	16	8	....	8	5	[illegible]
October	27	16	7	15	2	....	10	[illegible]
November	22	22	9	16	1	16	12	[illegible]
December	23	19	8	12	1	9	6	[illegible]
Total	373	261	98	13 c	14	112	7 c	[illegible]

a Includes two artesian wells. b Includes local consumption, estimated. c Averages. d Includes fifty-six wells in what is known as the Heavy Oil District; the production of this territory is not included.

An analysis of these tables shows that in 1898 there were completed 374 wells, of which thirty-two (8.56 per cent.) were dry, and four (1.07 per cent.) were gas wells. In 1899 there were completed 268 wells, of which ninety (33.2 per cent.) were dry and nine (3.3 per cent.) were gas wells. In 1900 there were completed 373 wells, of which ninety-eight (26.2 per cent.) were dry, and fourteen (3.7 per cent.) were gas wells. Taking the records for these three years it is found that there were 1015 wells at the close of 1900, of which 220 (21.6 per cent.) were dry, and twenty-seven (2.6 per cent.) were gas wells. A little more than one out of every five wells was dry, yielding neither oil nor gas. What the records will show with respect to the Beaumont field remains to be seen, but if the history of every other known oil field can be taken as a guide we may anticipate the finding of dry wells and gas wells there also. It is not every well that is put down, even in a small area known to be oil bearing, that yields oil. Only the drill can settle this question.

Mr. F. C. Thiele, in the *Oil, Paint and Drug Reporter*, gave the following analysis of Corsicana oil:

ANALYSIS OF PETROLEUM FROM CORSICANA, TEXAS.

	Per cent.	Sp. Grav.
Naphtha	10.8	0.710
Kerosene	54.5	0.796
Residue	34.7	0.905

The specific gravity of the crude oil was 0.8206, water being 1.0000.

Mr. E. H. Earnshaw made a more elaborate analysis of the Corsicana oil with the following result:

ANALYSIS OF PETROLEUM FROM CORSICANA, TEXAS.

Fractions.	Temperature, degrees Fahr.	Per cent.		Sp. Gravity at 60° F.
		By Vol.	By Wt.	
Colorless:				
A	130-200	2.80	2.34	0.6853
B	200-250	5.10	4.31	0.7017
C	250-300	7.60	6.60	0.7302
D	300-350	8.20	7.44	0.7527
E	350-400	9.40	8.75	0.7718
F	400-450	7.40	7.07	0.7929
G	450-500	8.30	8.00	0.8088
Very faint yellow:				
H	500-550	6.45	6.43	0.8290
I	550-600	7.75	7.85	0.8404
Yellow, J	600-650	14.95	15.43	0.8535
Deep reddish yellow, K	650-695	17.25	18.07	0.8687
Deep red (solid), L, over	690	1.30	1.41	0.8972
Dark red-brown (solid), M, over	690	1.40	1.68	0.9690
Residue			2.63	
Total		97.90	98.04	

Mr. Thiele's remarks on the oil were as follows: The oil is very dark brown and opaque, but thin and fluid at 60° F. The specific gravity at 60° F. is 0.8292. The oil is closely related to the oil from the Washington district, Penn., but contains asphaltum or bodies very similar to it. Oils containing asphaltum should be distilled with great care and a very gradual rise of temperature in order to avoid obtaining too much of the terpene-like decomposition products of the asphaltum in the distillates. These products resemble aromatic hydrocarbons and tend to make the oil yellow, which color is not much improved by acid treatment.

The Nacogdoches oil is heavy, specific gravity 0.915. The color is black and there is much sulphuretted hydrogen. It seems to belong to the malthas.

The oil from Saratoga, Hardin county, is heavier than the Nacogdoches oil, the specific gravity being 0.995. It is black and rich in asphaltum.

The oil from Sour Lake, Hardin county, has a specific gravity of 0.963 and an analysis of it is as follows:

ANALYSIS OF PETROLEUM FROM SOUR LAKE, HARDIN COUNTY, TEXAS.

Fraction.	Temperature, degrees Fahr.	Per cent. by Vol.	Specific gravity.	Color, etc.
1				
2	212-266	0.07		Yellow.
3	266-320	0.08		Yellow.
4	320-392	1.50	0.684	Yellow.
5	392-572	19.46	0.840	Yellow; blue fluorescence.
6				
7	572-641	5.15	0.792	Dark yellow.
Residue		71.11	0.978	Black.
Total		97.44		

The Sour Lake oil contained twenty per cent. of asphaltum. The greater portion of it appears to be composed of hydrocarbons excellently well adapted for lubricating purposes, and the last fraction had a viscosity of 19° (Engler apparatus), which is higher than any of the Russian products. When tested on a large scale, aromatic hydrocarbons were found, such as pseudocumene, etc., and the crude oil may be considered a true American representative of the German oil at Wietze-Steinforde. Prof. Engler thinks that this latter oil would yield most excellent lubricating products if it could be freed of its asphaltum. Solid paraffin has not been found in the Sour Lake oil, nor in any of the products refined from it.

In the Journal of the Society of Chemical Industry, Vol. XIX, No. 2, February 28, 1900, Mr. Clifford Richardson has an article entitled "Notes on Texas Petroleum" from which the following is taken:

CORSICANA OIL.

Specific gravity, 68° F.	0.8457
Beaumé	35.6 (about).
Flash	Ordinary temperature.
Volatile, 212° F.	10.8 per cent. (Naphtha).
Volatile, 324° F. 7 hours	35.7
Volatile, 399° F. 5 hours	11.2
Total	57.7

Residue after heating to 323° F. flows readily at 68° F. Has the appearance of containing paraffin. After heating to 399° F. residue has quick flow at 77° F.

ORIGINAL OIL DISTILLED AT ONE INCH PRESSURE.

	Distilled, per cent.	Color.	Sp. Gravity 68° F.	Refractive Index, D. at 68° F.
Crude oil		Dark reddish-brown, green fluorescence.		
Atmo. 125°-320° F.	4.0	Colorless	0.7386	1.415
1 inch. 127°-194° F.	6.2	Colorless	0.7611	1.423
194°-244° F.	7.4	Colorless	0.7829	1.436
244°-302° F.	10.4	Colorless	0.8018	1.447
302°-347° F.	10.8	Colorless	0.8167	1.456
*347°-356° F.	5.0	Colorless	0.8286	1.464
Residue	50.8	Reddish-brown		
Loss	5.4	Paraffin		

* Cracking begins.

DISTILLED AT ONE INCH PRESSURE AFTER TREATMENT.

Fractions.	Color.	Loss with		Sp. Gravity at 68° F.	Refractive Index, n. D. 68° F.
		Caustic soda.	Sulphuric acid.		
Atmo. 125°-194° F.	Colorless	2.5	2.9	0.7387	1.417
1 inch, 125°-194° F.	Colorless	2.6	2.8	0.7597	1.420
194°-244° F.	Colorless	2.1	2.2	0.7798	1.436
244°-302° F.	Colorless	1.2	1.4	0.7989	1.445
302°-347° F.	Colorless	2.1	3.0	0.8122	1.456
347°-356° F.	Colorless	4.2	7.2	0.8253	1.464
Residue.	Light reddish-brown; green fluorescence.		15.8	0.8900	1.494

SOUR LAKE OIL.

Specific gravity, 68° F.	0.9458
Beaume	18.0
Flash	244° F.

	Per cent.
Volatile, 212° F.	22.8 (water with trace of oil)
324° F. (7 hours)	12.6
399° F. (5 hours)	14.4
Total	49.8

Residue, after heating to 324° F., flows readily at 70° F.; asphaltic, pulls to long strings. After heating to 399° F. residue flows readily at 77° F.

RESULTS OF DISTILLATION OF ORIGINAL OIL AT ONE INCH PRESSURE AFTER REMOVING WATER.

	Distilled, per cent.	Color.	Sp. Grav. at 60° F.	Refractive Index, n.D. 60° F.
Crude oil		Reddish-brown; green fluorescence		
Fractions:				
212°-302° F.	6.6	Light yellow	[illegible]	1.474
302°-338° F.	12.7	Light green-yellow	[illegible]	[illegible]
338°-347° F.*	2.6	Light green-yellow	[illegible]	[illegible]
Residue	78.1	Reddish-brown maltha; very sticky		

* Cracking begins.

The fractions showed no paraffin at 32° F. The residue appears free from paraffin and is strongly asphaltic. For comparison some data are given in the subjoined table in regard to some petroleums from other well-known fields, taken from Mabery.

Ohio Oil—Mabery. Sp. Grav. [illegible]			Pennsylvania Oil—[illegible] Sp. Grav. 0.816.		
Fractions, 30 inches.	Distilled, per cent.	Sp. Grav.	Fractions, 30 inches.	Distilled, per cent.	Sp. Grav.
[illegible] F.	9.75	[illegible]	[illegible] F.	10.70	
[illegible] F.	16.63	[illegible]	[illegible] F.	[illegible]	[illegible]
[illegible] F.	10.75	[illegible]	[illegible] F.	15.22	[illegible]
[illegible]-572° F.	9.75	[illegible]	[illegible] F.	3.07	[illegible]
572°-[illegible] F.	8.93	[illegible]			
Distillate	55.51			64.43	
Residue	43.00			35.02	

The specific gravity of the Corsicana petroleum is a little heavier than that from near Dudley, Noble county, Ohio, 0.8457 to 0.8333. It is about the same as that of the lighter forms of California oil found in the Pica cañon, California. It is considerably heavier than that from the Pennsylvania fields. It flashes at the ordinary temperature and distills off a considerable percentage of naphtha below the temperature of boiling water. Its viscosity is the same as that of an Ohio Berea grit petroleum.

RESULTS OF TREATMENT WITH REAGENTS.

Fractions.	Color.	Loss with—		Specific Gravity at 60° F.	Refractive Index n. D. 60° F.
		Caustic soda.	Sulphuric acid.		
212°-302° F.	Colorless	2.0	1.5	[illegible]	1.475
302°-338° F.	Colorless	1.7	[illegible]	[illegible]	[illegible]
338°-347° F.	Colorless	5.0	10.6	[illegible]	[illegible]
Residue	Light reddish brown		12.2	[illegible]	[illegible]

Distilled under ordinary pressure, without particular precautions to prevent "cracking," Mr. Thiele found:

	Sp. Grav.
Naphtha, 10.8 per cent	0.710
Kerosene, 54.5 per cent	0.796
Residue, 34.7 per cent	0.905

Twenty grams of the oil, when heated for seven hours in an air bath at various temperatures, in a crystallizing dish two and one-fourth inches in diameter by one and one-half inches high, left a residue of 43.3 per cent., which flowed readily at 77° F. The residuum resembles that from Pennsylvania and Ohio petroleum and apparently contains paraffin scale. It is to a certain extent asphaltic, however. The crude oil, when distilled under a pressure of one inch of mercury, volatilized 51.2 per cent. at a temperature of 356° F., but at that point began to "crack." Ohio oil, on the contrary, did not begin to "crack" until 455° F. was reached at atmospheric pressure, but the Sour Lake oil broke up at the same point as did the Corsicana. It is, therefore, a less stable oil than our eastern petroleums.

The original distillates are not much acted upon by alkalies and acids nor do they separate any solid paraffin in a freezing mixture. They have rather high specific gravities for their boiling points, although not nearly as high as corresponding California distillates, and they contain aromatic substances and naphthene hydrocarbons, as shown, for the first, by the action of nitric acid, and for the second, by a combustion of the second distillate, 127°-194° F., at one inch after thorough treatment with caustic soda and sulphuric acid, which gave the following results:

Carbon	85.96
Hydrogen	13.97

The treatment with reagents reduces the density slightly in all the distillates, owing to the removals of phenols or acid substances, and of aromatic hydrocarbons and nitrogenous bases. The oil resembles neither the California oils of the Olinda district, nor the petroleum of the East.

The residuum of this oil is not attacked by acids much more than those of Eastern petroleums. The distillates after treatment with reagents are colorless, and remain so for some months on exposure to light.

The Sour Lake oil is a very heavy crude petroleum, 18° B., and corresponds in many respects with some of the heavier California oils of Summerland and Los Angeles in appearance and properties. It flashes at a low point for such a heavy oil, 244° F. As taken from the wells, it contains a very large amount of water. Heating the crude oil in an open dish to 399° F. for seven hours, volatilized thirty-five per cent. of the total, leaving a very soft asphaltic maltha, pulling out to a long string. Under a pressure of only one inch, only twenty-one per cent. was volatilized before "cracking" began. The distillates were colored, and of high density and refractive index. No paraffin could be separated from them at 32° F. The residuum appears free from paraffin. Sodium hydrate and sulphuric acid act but slightly on the lower distillates; more so, but not excessively, on the higher ones. The heated distillates color again after some time. The density is slightly reduced. The distillates between 212° and 302° F. at one inch gave the following figures on combustion after treatment with acids:

Carbon	85.92
Hydrogen	14.00

This is about the composition of the Corsicana oil of a little lower boiling point, and similar mode of preparation. It would point to the presence of paraffin hydrocarbons in both these petroleums, as the asphaltic oils contain much less hydrogen, as for example:

	Carbon.	Hydrogen.
Sunset Oil District, Cal., 298°-302° F., one inch	86.59	13.32
Asphaltic Oil 302°-330° F.	86.23	13.58

A comparison of the properties of these Texas oils with that from the Olinda (Fullerton) district in California will also show a decided difference. The specific gravities of distillates of similar boiling points under the same pressure show the differences and resemblences between them.

DISTILLATE, ONE INCH.

	Corsicana Oil.		Sour Lake Oil.		Fullerton Oil.	
	Before treatment.	After treatment.	Before treatment.	After treatment.	Before treatment.	After treatment.
122°-212° F.	0.7611	0.7397			0.8745	0.8160
212°-302° F.	0.7902	0.7853	0.8693	0.8623	0.9185	0.8598
302°-347° F.	0.8187	0.8132	0.9056	0.8980	0.9547	0.8774

The higher boiling asphaltic hydrocarbons of the California oil are of an enormously higher density than that of either of the Texas distillates, and so the latter can not be regarded as characteristically asphaltic, although no doubt containing unstable compounds of an asphaltic character. Then, too, the Fullerton residuum loses thirty-three per cent. of its weight to the ordinary reagents, whereas the Texas residuums are more nearly like those of Eastern petroleums.

PER CENT OF RESIDUUM IN NAPHTHA SOLUTION REMOVED BY STRONG SULPHURIC ACID.

	Per cent.
Fullerton, 1899	33.8
Summerland, 1894	25.8
Sour Lake, 1899	18.2
Corsicana, 1899	15.8
Ohio, 1897	13.6
Pennsylvania, 1897	10.5

The Texas oils, therefore, seem very likely to be both of the same origin and character, although one being from near the surface has developed its asphaltic properties more strongly than the other, as is found to be the case in California. They are both quite different from Eastern and Western oils.

In Bulletin No. 35, Texas Agricultural Experiment Station, there is given an analysis of Corsicana oil as follows:

ANALYSIS OF CORSICANA OIL, TEXAS AGRICULTURAL EXPERIMENT STATION.

The oil began to boil at 176° F. (80° C.)

	Yield, per cent. by volume.
From 176° to 194° F.	16.4
From 194° to 230° F.	7.8
From 230° to 284° F.	10.4
From 284° to 348° F.	9.2
From 348° to 392° F.	3.6
From 392° to 536° F.	16.0
From 536° to 581° F.	11.2
Above 581° F.	15.8
Total volatile	90.4

The following table gives a comparison of different oils, taken from Sadtler's Industrial Organic Chemistry, p. 18:

Crude Oil from—	Sp. Grav. at 60° F.	Began to boil at ° F.	Under 302° F. Per ct.	From 302° to 572° F. Per ct.	Over 581° F. Per ct.
Texas—Corsicana	0.821	176	34.6	40.0	15.8
Pennsylvania	0.818	180	21.0	38.0	40.7
Galicia	0.834	194	26.5	47.0	26.5
Baku	0.859	196	23.0	38.0	39.0
Alsace	0.907	275	3.0	50.0	47.0
Hannover	0.898	298	....	32.0	66.0

ANALYSIS OF CORSICANA OIL.

Dr. H. W. Harper, Professor of Chemistry in the University of Texas, has kindly placed at our disposal an analysis of a sample of Corsicana oil submitted to him in March, 1900.

Color, very dark brown, almost black; opaque except in thin layers; greenish fluorescence.

Viscosity, not determined; but the oil is very mobile at 32° F.

Sediment, none.

Water, none.

Flash point, 73° F.

Specific gravity at 63.5° F., 0.8586, equivalent to 33° Beaume.

Fractions.	Percentage.		Specific Gravity.	Color.
	By Vol.	By W'ght.		
77°-203° F	1.6	1.28	0.6912	Colorless.
203°-230° F	9.9	8.37	0.7295	Colorless.
230°-248° F	6.14	5.45	0.7650	Colorless.
248°-302° F	7.14	6.65	0.8000	Colorless.
302°-347° F	9.32	8.8	0.8107	Pale yellow.
347°-392° F	5.56	5.29	0.8211	Pale yellow.
392°-437° F	15.36	14.51	0.8115	Straw; blue fluorescence.
428°-437° F	8.0	7.54	0.8065	Light brown; blue fluorescence.
437°-482° F	12.0	12.30	0.8012	Light brown; blue fluorescence.
482°-536° F	8.7	8.45	0.8341	Brown; blue fluorescence.
536°-602° F	2.0	2.16	0.9005	Brown: solid at ordinary temperature.
Residue		9.2		
Total	85.72	90.11		

NOTE.—The yield of the fraction 77°-203° was greater than 1.6 per cent., but a portion of it was unfortunately lost before the entire amount was measured.

ANALYSIS OF CORSICANA OIL, 1898.

Mr. E. H. Earnshaw, chemist for the United Gas and Improvement Co., made an analysis of this oil with the following results:

The oil was described as very dark brown and opaque, but thin and fluid at 60° F. Specific gravity at 60° F., 0.8292.

Degrees F.—Fractions.	Per cent. by Vol.	Per cent. by W'ght.	Degrees Beaume	Sp. Grav. 60° F.	Colors, etc.
A. 120-200	2.80	2.24	80.00	[illegible]	Colorless.
B. 200-250	5.10	4.21	69.50	0.7017	Colorless.
C. 250-300	7.60	6.60	61.75	0.7292	Colorless.
D. 300-350	8.20	7.44	56.00	0.7527	Colorless.
E. 350-400	9.40	8.75	51.25	0.7718	Colorless.
F. 400-450	7.40	7.07	46.75	0.7930	Colorless.
G. 450-500	6.30	3.60	43.00	[illegible]	Colorless.
H. 500-550	6.65	6.43	39.50	[illegible]	Very faint yellow.
I. 550-600	7.75	7.65	36.50	0.8404	Very faint yellow.
J. 600-650	14.94	15.43	33.50	0.8555	Yellow.
K. 650-665	17.25	18.97	31.00	[illegible]	Deep reddish yellow.
L. Above 665	1.20	1.41	30.00	0.8678	Deep red—solid.
M. Above 665	1.40	1.53	14.50	[illegible]	Dark red brown—solid.
Residue		2.63			
Total	97.90	98.04			

In the Bexar county Cretaceous oil has been discovered in many localities. In fact there are few wells 500 feet deep in which flows of oil have not been encountered. In 1886, while drilling for water on his place six and one-half miles south of San Antonio, Mr. Geo. Dullnig struck a flow of heavy oil at a depth of 235 feet, and there was no water in the well. In a second well, located only fifteen feet from the first, precisely the same grade of oil was struck at a depth of 300 feet. A third well was put down in the same neighborhood to a depth of 900 feet, but the only flow encountered was at about 300 feet. The crude oil is used in its natural state as a lubricant and has stood excellent tests in railroad work and in all kinds of machinery. An analysis of the oil from Mr. Dullnig's well is given on page 51. The wells are cased with five and five-eighths inch iron pipe and are pumped only at irregular intervals, from one to three barrels being taken out at a time. The market is limited and only about fifty barrels are pumped in a year, nearly all of which is consumed locally. It is probable that a barrel a day could easily be obtained. No accurate log of the well is obtainable, but the oil is found in marly sand, overlaid by a heavy blue clay.

The San Antonio Oil Company has two wells on the tract of land south of the Dullnig property, two more in the process of drilling, and three more contracted for. The intention is to put in a plant to pump all the seven wells from one station. The oil is about the same quality as the Dullnig oil. Inside of the city of San Antonio numerous of the artesian wells have passed through an oil-bearing strata. In all the large wells belonging to the Water Company good flows were encountered at 500 feet.

Several years ago Mr. Dashiell encountered a strong flow of oil in a well on his place eight miles northeast of San Antonio. The oil was cased off, but rose to the surface on the outside of the casing and considerable difficulty was experienced in checking the flow.

A well on the ranch of Mr. F. T. Walsh on the Leona river, ten miles southwest of San Antonio, shows considerable oil at a depth of 180 feet. The well is cased only a hundred feet, but the oil has risen to within six feet of the surface. Gas is being given off constantly. An analysis of this oil has been made in the laboratory of the Survey (page 50). Oil has been reported from Sutherland Springs, twenty miles southeast of San Antonio, near the San Antonio & Gulf Railroad. The oil was struck in an eighty foot well and was cemented off. The well was four feet square and has since caved in, but a movement is on foot to reopen it. It seems, therefore, that oil is present on all sides of the city of San Antonio. Widespread interest is being taken in the oil showing of Bexar county and a number of companies have been formed for developing them. The field is quite extensive and it is probable that oil in larger quantities will be found in the region.

Mr. J. L. Tait, writing in the *Geological and Scientific Bulletin*, Vol. I, No. 10, February, 1889, gave a section of a well bored by the Crystal Ice Company, in San Antonio, at that time.

The section was as follows:

	Feet.
Gravel	40
Yellow clay	100
Bluish clay	230
Gravel	3
	373

A considerable gas pressure was encountered at this depth and chalybeate water, smelling of sulphuretted hydrogen, was blown out with great violence. The gas burned freely.

An analysis of the Dullnig oil, made in the laboratory of the Survey, by S. H. Worrell, June 15, 1901, gave the following results:

ANALYSIS OF THE DULLNIG OIL, BEXAR COUNTY.

Color, reddish-brown.
Flash point, 163° F.
Specific gravity at 75° F., 0.9019 (25° B).
Sulphur, 1.52 per cent.

	Distillation—Atmospheric Pressure.		Color.
	Per cent. by Vol.	Specific Gravity.	
80°-302° F.	1.10	....	Colorless.
302°-347° F.	2.20	0.7905	Colorless.
347°-392° F.	1.90	0.8164	Light yellow.
392°-437° F.	4.00	0.8327	Straw yellow.
437°-482° F.	2.60	0.8461	Straw yellow.
482°-527° F.	15.00	0.8522	Greenish yellow.
1st above 527° F.	15.60	0.8590	Light brown.
2nd above 527° F.	21.70	0.8658	Dark brown.
3d above 527° F.	21.70	0.8701	Reddish brown.
Residue	8.40	....	Coke & asphalt.
Loss	2.20		
Total	100.00		

Ten miles south of San Antonio and three miles beyond the Dullnig wells is another oil area known as the Walsh field. An analysis of the oil from this locality, made in the laboratory of this Survey by O. H. Palm June 14, 1901, gave the following results:

ANALYSIS OF THE WALSH OIL, BEXAR COUNTY.

Color, reddish-brown.
Flash point, 100° F.
Specific gravity at 75° F., 0.874 (30° B).
Sulphur, 2.02 per cent.

	Distillation—Atmospheric Pressure.		Color.
	Per cent. by Vol.	Specific Gravity.	
80°-212° F.	0.28	....	Colorless.
212°-257° F.	2.00	0.7288	Colorless.
257°-302° F.	2.45	0.7573	Colorless.
302°-347° F.	4.40	0.7712	Colorless.
347°-392° F.	6.00	0.7868	Colorless.
392°-437° F.	5.50	0.8065	Colorless.
437°-482° F.	4.30	0.8160	Colorless.
482°-527° F.	5.50	0.8287	Light yellow.
527°-572° F.	11.20	0.8361	Light yellow.
1st above 572° F.	slight	....	
2nd above 572° F.	23.67	0.8427	Straw yellow.
3d above	slight	....	
4th above 572° F.	24.40	0.8675	Reddish brown.
Residue	10.00	....	Coke & asphalt.
Loss	0.30		
Total	100.00		

A perceptible quantity of solid paraffin separated out between 392° and 482° F. The oil began to boil at 122° F. A blue fluorescence showed in the fractions 482°-527°, and 527°-572°, and a green fluorescence showed in the last two fractions.

Thirty miles west of the Dullnig wells and still in the Cretaceous there is another oil area five miles south of the town of Dunlay, Medina county. This field has not yet come into active production, but an analysis of the oil was made by Mr. O. H. Palm, in the laboratory of the Survey with the following results:

ANALYSIS OF OIL FROM NEAR DUNLAY, MEDINA COUNTY.

Color, reddish-brown.
Flash point, 110° F.
Specific gravity at 70° F., 0.8995 (26° B).
Sulphur, 2.09 per cent.

	Distillation at Atmospheric Pressure.		Color.
	Per cent. by Vol.	Sp. Grav.	
173°-275° F.	6.10	0.7519	Colorless.
275°-347° F.	4.36	0.7915	Colorless.
347°-437° F.	8.14	0.8138	Colorless.
437°-482° F.	9.20	0.8233	Light yellow.
482°-527° F.	10.90	0.8460	Straw yellow.
527°-572° F.	2.44	0.8541	Straw yellow.
1st. above 572° F.	19.71	0.8643	Light brown.
2nd. above 572° F.	14.10	0.8709	Dark brown.
3rd. above 572° F.	11.30	0.8763	Semi-solid asphalt.
Residue	16.01		
Loss	2.84		
	100.00		

The oil contains 6.10 per cent. by volume of the light oils and 32.60 per cent. of illuminating oil. It may also be possible to obtain illuminating oils from the distillates coming over above 572° F.

But few samples of the oil from the Cretaceous west of the Pecos river have been obtained. Following is an analysis of a sample recently secured.

Analysis of oil made by O. H. Palm under direction of Dr. H. W. Harper, Professor of Chemistry in the University of Texas, March 13, 1901.

The exact locality from which the oil came is twelve miles northeast of Fort Stockton. It is probably in the Cretaceous of Pecos county.

ANALYSIS OF OIL FROM PECOS COUNTY.

Color, very dark brown and opaque. Odor similar to that of Corsicana oil; more viscous than Corsicana oil.

Specific gravity at 71.6° F., 0.920 (22.2° B).

Flash point not determined.

Fractions.	By weight.	Color.
71.6°–302° F	1.79	Pale amber.
302°–455° F	3.47	Pale amber.
455°–496.4° F	6.51	Straw yellow.
496.4°–600° F	12.99	Straw yellow.
Above 600°	27.08	Brown; blue fluorescence.
Residue	45.54	Black viscous mass; asphaltic.
Loss	2.68	

This locality has been already referred to as being within a few miles of the "cienega," or marsh, extending in a northeast direction from Fort Stockton. The oil "seeps" from the ground and no borings have yet been made there.

CHAPTER IV.

OIL AND GAS-BEARING FORMATIONS—CONTINUED.

THE TERTIARY.

MARINE EOCENE.

This formation, in its largest development, lies to the eastward of the Cretaceous and between it and the Gulf. It comprises a very extensive area, probably in excess of 75,000 square miles. It is the area within which occur the best lignite beds and the brown ore deposits of East Texas. The coastal plain forms the south and southeast portion of it and probably occupies one-third of the total area now classed as Tertiary. There are other occurrences of the Tertiary in Texas, as, for instance, the Eagle Pass coal fields, a part of the Llano Estacado, and some territory along the Rio Grande, southeast of El Paso. But we need not consider these now, confining ourselves, for the present, to that portion of the Tertiary lying between the Cretaceous and the Gulf of Mexico.

In his Physical Geography of the Texas Region (United States Geological Survey, Washington, 1900) Mr. Robt. T. Hill has given very full and excellent descriptions of this part of the State and the reader is referred to this publication for more specific information. Mr. Hill divides it, broadly, into two groups, the Marine Eocene and the Coast Neocene, while the area west of the Permian and extending into New Mexico, he terms Non-Marine Tertiary. The reports of the Geological Survey of Texas, 1888-1892, may also be consulted.

In this State the Marine Eocene has not afforded oil in commercial quantities except at Nacogdoches, the oldest oil-producing district in the State. There are many localities where the indications for oil are of an encouraging nature and throughout the Marine Eocene generally there has been for some time considerable prospecting. The counties that lie wholly or in part in the Marine Eocene are the following: Bowie, Hopkins, Titus, Cass, Rains, Wood, Camp, Upshur, Marion, Van Zandt, Smith, Gregg, Harrison, Henderson, Rusk, Panola, Navarro (eastern part), Anderson, Cherokee, Nacogdoches, Shelby, Limestone, Freestone, Houston, Angelina, San Augustine, Sabine, Robertson, Leon, Trinity, Milam (eastern part), Brazos, Madison, Grimes, Walker, Polk (northern part), Tyler (northern part), Jasper (northern part), Newton (northern part), Burleson, San Jacinto (northern part), Lee, Washington (northern part), Bastrop (eastern part), Fayette (western part), Caldwell (eastern part), Guadalupe (eastern part), Gonzales, Lavaca (western part), Wilson, DeWitt, Karnes, Atascosa, Live Oak, Bee (northern part), Goliad (western part), La Salle, McMullen, Encinal, Duval (western part), Zapata, Starr (western part).

It is not meant that throughout this large area oil will be found in paying quantities, but that it has been found more or less abundantly, so far as concerns surface indications and those yielded by shallow wells, etc. As a matter of fact, there is at present no producing well in the Marine

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Eocene. Nor is it meant that deep borings will not penetrate through the formation in question, bringing oil up from an underlying and, perhaps, older formation. It is certainly to be expected that the overlying Eocene in places may not be very thick and that the beds underneath may be comparatively near the surface. In other places the contrary may be true, so that each locality will have to be judged in and for itself. The point is of no special importance, inasmuch as the Cretaceous is certainly not oil bearing throughout.

A section of a well bored eighteen miles southeast of Nacogdoches is given in Chapter I, page 2, and reference is also made in that chapter to the history of the Nacogdoches field, and an analysis of the oil is given. Whether this formation will come into the oil trade on a commercial scale only time will reveal, but there are sufficient indications at many points to warrant the opinion that oil in paying quantities will be found. The field from Oil Spring eastward and to San Augustine would seem to offer encouraging prospects.

The only commercial developments that have been made in the Marine Eocene are in Nacogdoches county, southeast of the town of Nacogdoches and in the vicinity of Oil Spring and Chireno. As reference has already been made to this field and an analysis of the oil given it is not necessary to dwell further upon it except to say that during the year 1900 the production was about 500 barrels, up to the end of March. After that date the wells were not worked. The field certainly merits attention and prospecting over a portion of it is now in progress. Natural gas was struck at Burke in the southwestern part of Angelina county early in the year and burned vigorously. The water from the artesian well at San Augustine, San Augustine county, is said to be strongly impregnated with oil. In the counties of Trinity, Shelby, Sabine, Polk, Walker, Newton, Tyler, Jasper, San Jacinto, etc., it is likely that much work will be done in the future and we can anticipate that the Nacogdoches field, the oldest producer in the State, will again come into prominence. In the southwest part of this formation not so much has been done, although it is said that many leases have been secured on promising lands. Up to this time most of the public interest centers around the Corsicana and the Beaumont field, and we will now take up the Coast Neocene, in which the Beaumont field lies and which is likely to afford a great proportion of the future production of the State, if, indeed, it does not speedily become by far the largest producer.

MARINE NEOCENE.

The counties that are wholly or in part in the Marine Neocene are the following: Newton, Jasper, Tyler, Polk, Hardin, Orange, Jefferson, Chambers, Liberty, San Jacinto, Montgomery, Harris, Galveston, Brazoria, Fort Bend, Waller, Washington, Austin, Colorado, Wharton, Matagorda, Jackson, Lavaca, Victoria, DeWitt (eastern part), Calhoun, Refugio, Goliad (eastern part), Bee (eastern part), San Patricio, Aransas, Nueces, Duval (eastern part), Starr (eastern part), Hidalgo, Cameron.

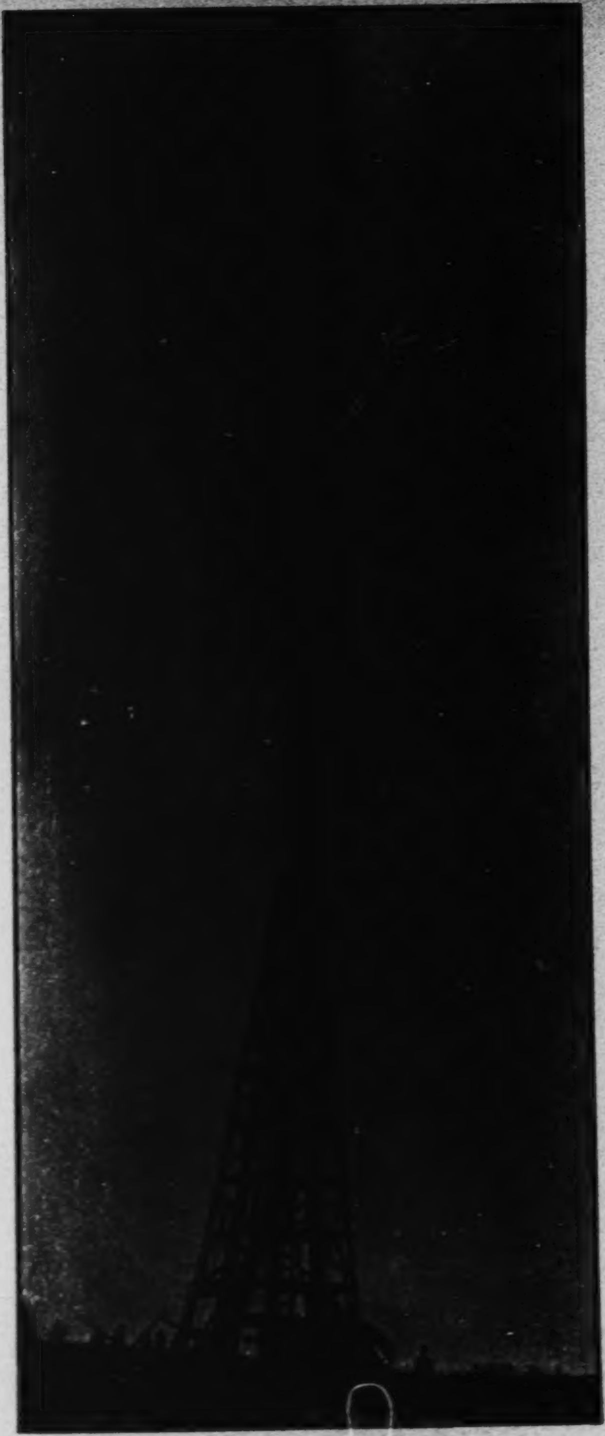
The area covered is about 33,000 square miles, and comprises a plain of uniform character, sloping gently to the east and southeast. It is, for the most part, devoid of any considerable prominences, the so-called hills, as, for instance, Big Hill, Jefferson county; High Island, Chambers county; Damond's Mound, Brazoria county, being local elevations of no great importance topographically. In the norther part of Newton county the topographic features are more pronounced and at places along the coast as, for instance, below Corpus Christi, the bluffs rise from sixty to seventy-five feet above tide. Except in the eastern portion, where the lumber interests are of great importance, the area generally is sparsely timbered. One of the few localities throughout the coastal plain where rock comes to the surface is at Damond's Mound, and in the earlier days limestone was burned for the production of lime here. The age of this limestone has not yet been determined, nor its geological relation to contiguous territory. Beds of sulphur and gypsum have been revealed by borings in the eastern part of the field and sulphur is known to exist also in the southwestern part of Starr county, together with oil.

It is said that as far back as 1847, in a letter written from the frontier, the owner of some lands near Beaumont expressed the belief that valuable minerals would some day be found there, but it is not known upon what he based his opinion. Taken in connection with the recent developments in the Beaumont district his prognostications would appear to be somewhat of a prophetic character.

Mr. Robt. T. Hill, of the United States Geological Survey, who, from his long experience in Texas, is entitled to speak with authority, wrote to the *Manufacturers' Record*, Baltimore, May 30th, as follows:

"In view of these facts (referring to the developments in the Beaumont field), the writer thinks it but wise to make a few statements concerning the geological conditions which control the occurrence of oil within the trans-Mississippi coastal plain. * * * It is my opinion that the Beaumont oil comes entirely from the eocene and neocene tertiary strata, which have an aggregate thickness of 2000 feet or more and outcrop the entire distance across the State from Red river to the Rio Grande, in the region of country known as the East Texas Timber Belt. These strata dip coastward beneath the coast prairies at a rate, as yet undetermined, of from five to fifteen feet per mile, where they are embedded (overlain) by from nothing to 1500 feet of later sediments of pleistocene age. Many fragmentary geological observations have been made upon the Tertiary strata of Texas, but no adequate nomenclature of classification has as yet been arrived at. * * * The strata of the greater oil field of the trans-Mississippi coastal plain present two important phases, the outcrop and the embed. It is in the outcrop in the timber belt that oil is seen to be actually oozing from the strata or struck in shallow wells, but the copious oil wells will all be derived from the embed beneath the coastal prairies."

One of the most interesting and important contributions to our knowledge of the formations beneath the surface in the coastal plain is afforded by the section of the deep well bored at Galveston, sixty-six miles southwest of Beaumont. This well was begun April 14, 1891, and was completed during the latter part of August, 1892, the total depth being 3070 feet. The well was bored under the supervision of Mr. J. W. Byrnes, and in the *Engineering News*, August 11, 1892, he gave a description of the methods employed, etc. The well was started with a 22-inch casing with which the surface sand, etc., was removed to a depth of fifty-seven feet. Inside this casing from this depth to 870 feet there was a 15-inch casing, and inside of this, to a depth of 1500 feet, there was a 12-inch



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casing. At this depth the 12-inch pipe was telescoped with a 9-inch pipe down to a depth of 2363 feet. From this point there was used 200 feet of 8-inch and 212 feet of 7-inch pipe to a depth of 2600 feet. At this depth, by means of a 6½-inch shoe on a 4-inch pipe the boring was continued to 2920 feet. The total depth reached was, as already stated, 3070 feet.

The well was not successful in securing sufficient acceptable water, and the boring was discontinued. The contract price was $75,000, completed to 3000 feet and finished with 6-inch pipe.

The section of the well was given in a paper by Mr. J. A. Singley in a separate pamphlet (with Mr. G. D. Harris' paper on the Organic Remains from the Well) in the Fourth Annual Report of the Geological Survey of Texas, 1892, and is as follows:

GALVESTON DEEP WELL SECTION.

From—	To—	Made feet.	Formation.
Surface	46	46	Buffy gray sand.
46	63	17	Reddish brown clay, enclosing calcareous concretions, ferruginous sandstone, quartz pebbles, nodules of dark gray clay and shell fragments, the only species being *Labiosa canaliculata*, Say.
63	100	37	Mottled red and blue clay, full of shell fragments. The last 15 feet of this clay was full of lignitic matter, and gave fewer shells.
100	110	10	Gray sandy clay.
110	167	57	Fine gray sand, containing some fragments of lignite.
167	279	112	Buff colored sandy clay.
279	305	26	Fine gray sand, containing a few fragments of lignite, and in the lower 5 feet a few fragments of *Leda concentrica*, Say? (smooth form), and *Mactra lateralis*, Say.
305	315	10	Grayish brown clay, enclosing fragments of lignite and well preserved shells of the following species: *Arca floridana*, Con.? (young), *Leda concentrica*, Say? (smooth form), *Donax tumida*, Phil., *Syndosmya aequalis*, Say, *Mactra lateralis*, Say.
315	440	125	Fine sand, varying in color from gray to ashy gray and buffy gray. Fragments of lignite were met with throughout this bed, and the last 25 feet were slightly micaceous.
440	458	18	Grayish brown clay, containing fragments of lignite, shells, coral, and a fragment of the claw of a crustacean. Of the shells the following have been determined: *Arca floridana*, Con.? (young), *Leda concentrica*, Say? (smooth form), *Donax tumida*, Phil., *Syndosmya aequalis*, Say, *Mactra lateralis*, Say, *Nassa acuta*, Say, *Anachis obesa*, C. B. Ad., *Odostomia conoidea*, Brocc.
458	468	10	Gray sandy clay, slightly micaceous.
468	497	29	Brownish gray sandy clay.
497	575	78	Fine light gray clayey sand, micaceous.
575	588	13	Brownish gray sandy clay.
588	612	24	Gray sand, micaceous.
612	647	35	Brownish sandy clay, a few shell fragments.
647	674	27	Light gray sandy clay.
674	706	32	Reddish brown sandy clay, with finely comminuted shell fragments.
706	720	14	Buffy colored sand, slightly micaceous.
720	737	17	Brownish gray clayey sand.
737	827	90	Light gray clayey sand, the last 11 feet containing a few fragments of shells and large pieces of lignite.
827	862	35	Coarse silvery gray sand, composed of angular fragments of translucent and smoky quartz, not much water worn. (This is the water-bearing sand from which most of the city's water supply is derived.)
862	873	11	Buffy sandy clay.
873	883	10	Gray sand, full of fragments of lignite and a few shells. Two of the species determined are: *Arca floridana*, Con.? (young) and *Syndosmya aequalis*, Say.
903	911	8	Brownish clayey sand.

From—	To—	Made feet.	Formation.
911	914	3	Indurated coarse gray sand, enclosing fragments of lignite and shells (to finely comminuted for determination), calcareous concretions, and small ferruginous sandstone pebbles.
914	930	16	Fine ashy gray micaceous sand.
930	1,032	102	Fine clayey sand, changing from brownish gray above through olive buff to ashy gray below, micaceous throughout.
1,032	1,260	228	Sandy clay, varying buffy, brownish, and greenish tints.
1,260	1,288	28	Coarse gray quartz sand (water-bearing sand).
1,288	1,319	31	Greenish gray sandy clay.
1,319	1,330	11	Buff colored clay.
1,330	1,340	10	Coarse gray sand, composed of rounded, water-worn fragments of quartz (water-bearing sand).
1,340	1,357	17	Greenish gray sandy clay.
1,357	1,367	10	Brownish clay.
1,367	1,384	17	Ashy gray clay.
1,384	1,393	9	Reddish tinted coarse gray sand.
1,393	1,410	17	Greenish sandy clay.
1,410	1,430	20	Buffy sandy clay.
1,430	1,448	18	Greenish sandy clay, the last 6 feet changing to buffy color.
1,448	1,454	6	Medium coarse sand of rounded fragments of translucent and smoky quartz; a ferruginous stain gives this sand a reddish tint.
1,454	1,482	28	Greenish gray sandy clay, the lower 9 feet shading into buffy color.
1,482	1,493	11	Brownish clay.
1,493	1,511	18	Greenish gray sand, micaceous (water-bearing sand).
1,511	1,606	95	Laminated greenish clay, containing small rounded pebbles of ferruginous quartz and sandstone, jasper, flint, calcareous concretions, and a few fragments of opalized wood; shells, lignitized wood and fruits, and fragments of claws of a crustacean. Of the shells, only three species have been determined: *Nassa acuta*, Say, *Chione cancellata*, L., *Mactra lateralis*, Say.
1,606	1,628	22	Brownish gray sandy clay.
1,628	1,754	126	Brownish gray clayey sand.
1,754	1,758	4	Cream-colored gritty calcareous conglomerate.
1,758	1,780	22	Fine gray sand, micaceous.
1,780	1,800	20	Olive-buff sandy clay.
1,800	1,822	22	Fine greenish gray sand, micaceous.
1,822	1,845	23	Olive-buff sandy clay.
1,845	1,876	31	Fine dark gray sand.
1,876	1,895	19	Brownish clay, containing fragments of lignite, calcareous concretions, and finely comminuted shell fragments.
1,895	1,923	28	Dark gray sand, micaceous.
1,923	2,036	113	Greenish sandy clay, containing calcareous concretions and lignitized wood and fruits. A few broken shells were taken from between 1,970 and 1,980 feet
2,036	2,060	24	Fine gray clayey sand.
2,060	2,068	8	Buffy sandy clay.
2,068	2,097	29	Greenish gray clayey sand.
2,097	2,138	41	Laminated greenish clay, containing calcareous concretions, fragments of lignite, and shells too poorly preserved for identification.
2,138	2,153	15	Fine dark gray sand, micaceous.
2,153	2,196	43	Greenish clay (the first 10 feet laminated), containing lignitized wood and well preserved fruits and corals. The color markings have been preserved on some of the shells from this stratum. The following have been identified: *Crassatella gibbesii*, T. & H., *Terebra dislocata*, Say, *Pleurotoma albida*, Perry, *Cancellaria reticulata*, L., var., *Oliva literata*, Lam., *Solarium granulatum*, Lam., *Natica canrena*, Lam., *Natica duplicata*, Say. The lower 25 feet contained only fragments of shells, and but little lignite.
2,196	2,220	24	Indurated fine gray sand.
2,220	2,249	29	Dark colored clay, full of lignitized wood and fruits, corals, fish vertebrae, and shells. Of the latter the following have been identified: *Arca floridana*, Con.? (young), *Crassatella gibbesii*, T. & H. var., *Lucina floridana*, Con., *Venus mercenaria* L.?, *Mactra lateralis*, Say, *Dentalium tetragonum*, Say, *Terebra dislocata*, Say, *Conus punctulatus*, Hwass, *Pleurotoma albida*, Perry, *Cancellaria reticulata*, L. var., *Oliva literata*, Lam., *Solarium granulatum*, Lam., *Natica canrena*, Lam., a terrestial species, *Polygyra hindsi*, Pfr., and a fluviatile shell, *Amnicola peracuta*, Pilsbry & Walker.

From—	To—	Made feet.	Formation.
2,249	2,288	39	Light buffy gray clayey sand.
2,288	2,291½	3½	Siliceous calcareous shell conglomerate of a bluish gray color and very hard, taking 40 hours to go 3½ feet.
2,291½	2,310	18½	Buffy gray clayey sand.
2,310	2,323	13	Light gray sand, micaceous.
2,323	2,330	7	Brownish sandy clay.
2,330	2,345	15	Greenish gray clayey sand.
2,345	2,377	32	Medium coarse gray sand, composed of well rounded translucent and smoky quartz fragments, micaceous (water bearing sand).
2,377	2,387	10	Greenish clay, enclosing a few comminuted shell fragments and particles of lignite.
2,387	2,410	23	Mottled blue and brownish clay, containing calcareous concretions, rounded pebbles of ferruginous quartz, nodules of pyrite, fragments of lignitized wood, shark teeth, and shells of the following species: *Crassatella gibbesii*, T. & H. var., *Lucina dentata*, Wood, *Venus mercenaria*, L., *Dentalium tetragonum*, Sby., var., *Terebra dislocata*, Say, *Conus punctulatus*, Hwass, *Pleurotoma albida*, Perry, *Cancellaria reticulata*, L., var., *Oliva literata*, Lam., *Natica canrena*, Lam., *Natica duplicata*, Say.
2,410	2,425	15	Laminated blue clay, containing calcareous concretions, pyrite, rounded calcareous and ferruginous sandstone pebbles, lignite, coral, shark teeth, and shells of the following species: *Arca labiata*, Sby., *Lucina crenulata*, Con., *Chione cancellata*, L., *Pholas costata*, L., *Dentalium tetragonum*, Sby., var., *Terebra dislocata*, Say, *Conus punctulatus*, Hwass., *Cancellaria reticulata*, L. var., *Oliva literata*, Lam., *Strombina gibberula*, Sby., var., *Natica canrena*, Lam., *Natica duplicata*, Say.
2,425	2,432	7	Red and greenish mottled clay, containing a few rounded pebbles of flint, pyrite in nodules, lignite, coral, and shells, of which the following have been determined: *Arca floridana*, Con? (young), *Dentalium tetragonum*, Sby., var., *Terebra dislocata*, Say, *Conus punctulatus*, Hwass.
2,432	2,443	11	Buff colored sand of rounded quartz fragments (water-bearing.
2,443	2,451	8	Mottled brown and greenish clay, with calcareous concretions, lignite, fish vertebræ, and the following species of shells: *Arca incongrua*, Say, *Lucina crenulata*, Con., *Pleurotoma albida*, Perry, *Strombina gibberula*, Sby., var., *Natica canrena*, Lam., *Venus mercenaria*, L.?, *Chione cancellata*, L., *Conus punctulatus*, Hwass., *Melongena melongena*, L., *Nassa acuta*, Say, *Polygyra hindsi*, Pfr.
2,451	2,453	2	Lignite.
2,453	2,476	23	Mottled brown and greenish clay, with calcareous concretions, rounded pebbles of bluish siliceous limestone, lignite, coral, fish spines and vertebræ, otolithes, and water-worn shells, of which the following species have been determined: *Crassatella gibbesii*, T. & H. var., *Arca floridana*, Con.? (young), *Lucina floridana*, Con., *Venus mercenaria*, L.?, *Chione cancellata*, L., *Pholas costata*, L., *Dentalium tetragonum*, Sby. var., *Terebra dislocata*, Say, *Conus punctulatus*, Hwass., *Melongena melongena*, L., *Pleurotoma albida*, Perry, *Cancellaria reticulata*, L., var., *Oliva literata*, Lam., *Strombina gibberula*, Sby., var., *Solarium granulatum*, Lam., *Natica canrena*, Lam., *Natica duplicata*, Say, *Lunatia catenoides*, Gabb.
2,476	2,485	9	Light gray colored sand (water-bearing sand).
2,485	2,504	19	Dark gray sand, somewhat coarser than the last.
2,504	2,521	17	Light buffy gray sand, micaceous.
2,521	2,552	31	Dark gray sand, micaceous. The last three beds are a continuation of the water-bearing sand just mentioned.
2,552	2,567	15	Laminated greenish clay, with calcareous concretions, fish vertebræ, otolithes, shark teeth, and shells, of which the following species have been determined: *Arca floridana*, Con.? (young), *Arca incongrua*, Say, *Leda concentrica*, Say?, (smooth form), *Lucina crenulata*, Con., *Lucina dentata*, Wood, *Mactra lateralis*, Say, *Terebra dislocata*, Say, *Solarium granulatum*, Lam., *Natica canrena*, Lam.

From—	To—	Made feet.	Formation.
2,567	2,598	31	Greenish gray micaceous sand. A large number of shells were secured from this sample, but there is no doubt but that many of them came from the clay immediately overlying the sand, as the clay was caving in when the pipe was penetrating the sand. The following species have been determined: *Arca carolinensis*, Con. *Arca floridana*, Con.?, (young), *Arca incongrua*, Say, *Leda concentrica*, Say, *Crassatella gibbesii*, T. & H. var., *Lucina crenulata*, Con., *Lucina dentata*, Wood, *Cardium magnum*, Born., *Venus mercenaria*, L.?, *Chione cancellata*, L., *Donax carinata*, Hanley, *Mactra lateralis*, Say, *Labiosa canaliculata*, Say, *Dentalium tetragonum*, Sby., var., *Terebra dislocata*, Say, *Conus puncticulatus*, Hwass., *Pleurotoma albida*, Perry, *Cancellaria clavatula*, Sby., *Cancellaria reticulata*, L. var., *Oliva literata*, Lam., *Strombina gibberula*, Sby., var., *Turritella subgrundifera*, Dall. var., *Natica canrena*, Lam., *Natica duplicata*, Say, *Lunatia eminuloides*, Gabb, *Sigaretus perspectivus*, Say.
2,598	2,631	33	Mottled brown and greenish clay, containing a large number of shells, but mostly fragmentary.
2,631	2,637	6	Fine ashy gray sand.
2,637	2,698	61	Brownish sandy clay, hard, containing fish vertebrae and teeth, otolithes, coral, and shells of the following species: *Arca floridana*, Con.? (young), *Arca incongrua*, Say, *Leda concentrica*, Say, *Crassatella gibbesii*, T. & H., var., *Lucina crenulata*, Con., *Lucina dentata*, Wood, *Lucina floridana*, Con., *Mactra lateralis*, Say, *Dentalium tetragonum*, Sby., var., *Cylichna bidentata*, d'Orb., var., *Terebra dislocata*, Say, *Conus puncticulatus*, Hwass., *Pleurotoma albida*, Perry, *Cancellaria reticulata*, L., var., *Oliva literata*, Lam., *Strombina gibberula*, Sby., var., *Natica canrena*, Lam., *Natica duplicata*, Say. All these species were taken between [illegible] and [illegible] feet.
2,698	2,717	19	Buffy clayey sand.
2,717	2,883	166	Greenish clay, laminated after the first 16 feet, with calcareous concretions, cylindrical gray sandstone casts or concretions, waterworn limestone pebbles, lignite, coral, fish vertebrae, spines, and teeth, otolithes, claws of a crustacean, and many well preserved shells. Fragments of lignite with Teredo borings, and a well preserved lignitized cone of one of the conifers were found in this bed. The last 60 feet changed to a bluish color. Of the shells the following have been determined: *Arca floridana*, Con.?, (young), *Arca incongrua*, Say, *Arca carolinensis*, Con., *Crassatella gibbesii*, T. & H. var., *Lucina crenulata*, Con., *Lucina dentata*, Wood, *Lucina floridana*, Con., *Chione cancellata*, L., *Mactra lateralis*, Say, *Labiosa canaliculata*, Say, *Cylichna bidentata*, d'Orb., var., *Terebra dislocata*, Say, *Terebra concava*, Say, *Conus puncticulatus*, Hwass., *Pleurotoma albida*, Perry, *Cancellaria reticulata*, L., var., *Oliva literata*, Lam., *Turritella subgrundifera*, Dall., var., *Strombina gibberula*, Sby., var., *Solarium granulatum*, *Natica canrena*, Lam., *Lunatia eminuloides*, Gabb.
2,883	2,920	37	Gray sand, the grains of very uniform size of rounded translucent quartz. A few grains of smoky quartz were also found in this sand. A strong flow of water was encountered in this bed, forcing the sand for 200 feet up the pipe and taking some time to overcome. The water was brackish.
2,920	2,985	65	Gray clayey sand.
2,985	3,025	40	Brownish sandy clay.
3,025	3,047	22	Dark gray sandy clay, micaceous and containing a few fragments of lignite.
3,047	3,070	23	Coarse gray sand of rounded translucent quartz fragments, slightly micaceous (water bearing sand).

In discussing the character of the shells, etc., from this boring Mr. Harris remarks that many of the forms are new and peculiar and will have to be carefully studied. Again, many of the well-known forms vary in the characteristics presented.

"The fossils obtained are, upon the whole, of an unsatisfactory nature for correlation work, i. e., they contain many recent species and many new ones, while the number of forms characteristic of known geological horizons is very small. Nevertheless, it is believed that there are certain conclusions that can safely be drawn from the accompanying table which will be of considerable value to the stratigraphical geologist in Southern Texas as well as to geological science. The conditions may be summed up as follows:

"1. Of the eleven species obtained from samples numbered from 2 to 19 (0 to 458 feet), inclusive, all, except the new form of Eriphyla, are recent and well-known forms. In all probability, therefore, the strata passed through between depths ranging from 0 to 450 feet must be referred to a Post-Tertiary or Pleistocene epoch. The small Eriphyla will probably be found recent on the Gulf shore.

"2. The fauna is so sparse between Nos. 38 and 125 (816 to 2138 feet), inclusive, that it is unsafe to attempt to state just where in the upper Tertiary it should be placed. In fact, beds included between depths 450 and 1500 may not be Tertiary at all, but Pleistocene. The undescribed, and probably for the most part extinct, species occurring from depths 1500 and 2150 feet show conclusively that the beds here penetrated are Tertiary.

"3. The fossils obtained from depths 2158 to 2920 feet show that this part of the well-section must be referred to the Miocene series. Moreover, it is quite evident that upon the whole the fauna here represented is that of the upper rather than the lower Miocene. Out of about seventy-two species, twenty-six are still living on the Atlantic or Gulf coast of the United States, while six more survive only in the Pacific. Of the thirty-six new or doubtful forms probably the great majority are extinct, though it is unsafe to predict what will yet be found in the Gulf of Mexico. *Arca carolinensis*, *Turritella subgrundifera* var., *Chione* sp. nov. of West Florida Miocene, *Terebra* n. sp. of West Florida Miocene, and *Natica eminuloides* of the West Indian Miocene may be regarded as characteristic species, leaving no doubt, when taken in connection with the foregoing facts, that this portion of the well section belongs to the Miocene series, and in all probability to the upper part of the same.

"The above conclusions may be stated diagrammatically as follows:

Depth in feet.	Geological horizons.
46 to 458	Pleistocene.
458 to 1510	Doubtful.
1510 to 2158	Upper Tertiary.
2158 to 2920	Miocene (upper).

"Probably some of the strata between the depths of 458 and 2158 feet were deposited in Pliocene times, but not a trace of a species characterising that series was found.

"In addition to the marine species enumerated in the table, the following fresh-water forms were obtained:

"*Polygyra hindsi*, Pfr. var., from a depth of about 2200 feet and again from a depth of about 2450 feet. *Amnicola*, not distinguishable from *peracuta*, at a depth of about 2240 feet. These two occur recent in Texas."

Some shells that were secured from a depth of 390 feet in the Beaumont district were sent to Mr. T. H. Aldrich, Birmingham, Ala., for identification. His reply is as follows, under date of June 22nd:

(NOTE.—The table referred to by Mr. Harris merely presents his results in a condensed form and it is not necessary to reproduce it. The only Eocene shell, and that questionable, was *Lucina dentata*, Wood. All the others are marked Miocene, Pliocene and Recent.)

"Your fossils are very interesting and confirm our previous theory that the formation that lies above the oil-bearing stratum around Beaumont is Pliocene or even later. There were four species in the box.

"No. 1 is a new species of *Nassa** and can be characterized as follows: *Nassa beaumontensis*, n. sp.

"Shell cancellated, whorls seven, the first two smooth, the others with two strongly nodular transverse lines, except the body whorl which has six or seven. Aperture with both outer and inner lip dentate; canal short. Length, 8 m. m.; breadth, 4 m. m. This species resembles *Nassa bidentata*, Emmons, but is much more strongly nodular and has but two transverse or spiral ribs, and also possesses one more whorl. The shell resembles a species of Phos externally.

"No. 2. *Tornatina canaliculata*, Say. This species occurs in the Miocene of Jamaica, in the Pliocene of the eastern United States, and is living in the Gulf of Mexico.

"No. 3. Turbonilla, sp. These specimens strongly resemble forms now living in the Gulf.

"No. 4. Young Mactra, or rather Spisula, which is a mactroid genus. * * * The general aspect of these forms is decidedly Pliocene, or even more recent, as already stated. I have three or four more species from the Lucas well, but the specimens are very imperfect. They also tend to confirm the Pliocene horizon."

The shells from the Lucas well that were examined by Prof. Van Ingen, Columbia College (see paper of A. F. Lucas, in Trans. Amer. Inst. Min. Engrs., Richmond meeting, Feb., 1901), were said to be clearly Tertiary, but whether Eocene or Miocene did not appear, as the specimens were much mutilated. The specimens sent to Mr. Aldrich were in good preservation and his reference of the overlying strata to the Pliocene is based on well-marked individuals.

In a communication to *Science*, April 26th, Mr. G. D. Harris, of Cornell University, and State Geologist of Louisiana, said that the shells which he obtained convinced him that the Tertiaries had not been completely penetrated. He thought also that the cap rock had a decidedly Cretaceous appearance. There is considerable difficulty in saying just what is the cap rock, as a sample submitted to us as representing the cap rock was limestone and another specimen, said to represent the cap rock, was identified by Prof. Van Ingen as sandstone. Mr. Harris thought that the well from which he secured his specimens had penetrated possibly a thousand feet of rather recent or newer Tertiary strata and had then come upon some portion of a Cretaceous anticlinal fold or ridge, and he is of the opinion that the conditions in the Beaumont field are a repetition of the "Sulphur Mine" conditions of southwestern Louisiana, buried about twice as deep beneath the surface by recent formations.

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* *Nassa acuta* was found by Mr. G. D. Harris in material from the Galveston deep well, depth [illegible] to [illegible] ft., again at a depth of 1,511 to [illegible] ft., and again at 2,443 to 2,451 ft. at this depth with a fresh water recent species, *Polygyra hindsi*.

From the examination of species sent to him from a depth of 390 feet in one of the Beaumont oil wells, Mr. T. H. Aldrich, in a letter already quoted, considers that at this depth the formation was probably Pliocene, while Mr. Harris considered the formation in the Galveston deep well, to this depth as Pleistocene, or Recent, and did not think that the Upper Tertiary was reached above 1500 feet, which is much below the bottom of any producing well in the coastal plain. The evidence so far gathered is in favor of a post-Cretaceous origin of the Beaumont oil and this view is sustained alike by paleontological and chemical data. The chemical composition of the Beaumont oils is entirely different from that of the Cretaceous oils.

It is held by Mr. W. L. Watts, of the California State Mining Bureau, that the oil from the Puente Hills and at Los Angeles is from rocks of the Neocene age, although many Pliocene shells are found in them. To the south of the valley of the Santa Clara river, in the counties of Ventura and Los Angeles, the range is from Neocene to Miocene, while on the north side of the valley the range is from Upper Neocene to Lower Eocene. West of Bakersfield, Kern county, the oil-bearing rocks are thought to be Miocene, although they may be Pliocene. Natural gas and oil are also found in the Cretaceous of Colusa county, and in San Joaquin county gas is found in the Quaternary.

In Galicia (Austria-Hungary) the oil-bearing rocks range in age from the Cretaceous to the Miocene, the conditions being similar to those that exist in California, and the same is to a large extent true of the Roumanian field.

The Russian oil (Apsheron Peninsula, Baku field) is obtained from the Lower Miocene (Tertiary) and pyrite is associated with the oil-bearing rocks. The conditions there are not dissimilar to those in the coastal plain region of Texas, nor is there much difference in the two oils, except in respect of the sulphur content which is higher in the Texas than in the Baku oil. It is quite possible that the development of the coastal plain oils here will follow along the lines already laid down there, for the two oils are essentially fuel oils. Perhaps a brief account of the conditions surrounding the oil trade there may not be out of place here.

In 1880 the production of crude oil on the Apsheron Peninsula was 3,055,247 barrels; in 1885, 14,179,833; in 1890, 29,217,126; in 1895, 47,713,983; and in 1899, 66,452,240. The total Russian production in 1899 was 68,752,240 barrels, the other 2,300,000 barrels coming from the Grosni district in the Caucasus. The average yield was, in the Baku district, 172,661 barrels a day from 1357 wells, or about 127 barrels per day per well. In the United States the average yield per day was about 156,000 barrels from about 82,000 wells, say, two barrels a day. It takes sixty American wells to produce in one day as much as one Russian well.

In 1899 in the Baku district there were completed 370 wells of an average depth of 911 feet and yielding, on the average, 202 barrels each, per day. In 1898 the number of wells completed was 258, of an average depth of 937 feet, and an average yield of 653 barrels each, per day. The average daily production of the Baku flowing wells was 37,202 barrels in 1898 and 26,445 barrels in 1897, as against 122,413 and 146,216 barrels, respectively, for the pumping wells, in 1899. The production of the flowing wells in 1899 was about one-sixth of that of the pumping wells.

The pumping system in use is not what we know as "pumping," but is really baling, the baler bringing up from two to four and even six barrels at a time. The pipes are large, generally 16-inch, and some of the balers are forty feet in length. For drilling, the rod, or Canadian, system is used, and it requires from one to two years to bring a well in. Mr. Oliphant (Rep. on Petroleum, U. S. Geol. Survey, 1899) states that in one well there were used 84 feet of 26-inch pipe, 252 feet of 24-inch, 420 feet of 22-inch, 588 feet of 20-inch, 756 feet of 18-inch, and 923.7 feet of 16-inch. The entire weight of the pipe was nearly eighty-seven tons, and the cost was $5,944; the drilling cost $5,898, and other expenses, such as riveting, power, lights, brought the total cost of the well up to $16,275, or $5.38 per foot, completed.

It is said that the increasing royalties in the Baku district, consequent upon government ownership of the land, may increase the cost of production. Many of the government leases require the payment of a minimum royalty, whether oil is produced or not, and prices vary from eleven to forty-six cents per barrel, having risen from about two cents per barrel. During the first part of 1899, according to a report of Consul Chamberlain, the price of Baku crude varied from seventy to eighty cents a barrel, but rose to $1.05 by the close of the year. At this writing (July, 1901) the price is about thirty-eight cents a barrel.

Mr. Benjamin F. Hill, Assistant Geologist of the Survey, reports as follows on the Beaumont field:

"Jefferson county, in which one of greatest oil strikes of the last quarter century has been made, lies in the extreme southeastern part of the State of Texas, being bordered on the east and northeast by Cameron Parish, La., and Orange county, Texas; on the north by Hardin county; on the west by Liberty and Chambers county; and on the south by the Gulf of Mexico. Its area is 960 square miles, all of which consists of coastal plain, with very little timber land. The whole territory has hitherto been occupied by grazing and rice lands.

"Although a considerable number of wells have been drilled in various parts of the county, the only district up to this date (July) where oil has been struck in paying quantities is on Spindle Top Heights, a low ridge of land lying about four miles south of the town of Beaumont. The extent of this ridge, which, at its highest point, is about thirty feet above the level of the surrounding prairie, is, roughly speaking, one mile wide by two miles long, its greatest length being approximately northeast to southwest. The Lucas "gusher" is located near the south end of the ridge. It is probable that this rise of ground is due to a flexure in the strata forming the earth's crust, though it is possible that erosion may have been instrumental in shaping its present topography.

"The geological age of the various strata penetrated have not as yet been definitely determined. The various opinions and criteria upon which they are based are given elsewhere in this Bulletin.

"The various operations leading up to the bringing in of the Lucas well in January, 1901, have been referred to and discussed in a previous chapter. Since the event mentioned, which may be regarded as the date from which the Beaumont district became an oil producer, the development has been very rapid. Excitement was for a while at fever heat

TANKS AT EL VISTA. J. M. GUFFEY PETROLEUM CO. CAPACITY, 50,000 BARRELS EACH.

and as a natural result many unwise investments were made. At this time, however (July), it may be said that the cooler calculations of every-day business have supplanted the earlier craze, and that the district is being developed with conservative speed.

"At present six companies have succeeded in bringing in wells. These are as follows:

J. M. Guffey Petroleum Co.	6 wells.
Heywood Oil Co.	3 wells.
Higgins Oil and Fuel Co.	2 wells.
National Oil and Pipe Line Co.	1 well.
Lone Star and Crescent Oil Co.	1 well.
Hogg-Swayne Syndicate	1 well.

"All these wells are in a comparatively limited area on Spindle Top. A rectangle 2000 by 1000 feet would include all the present producers. The productive area, will, without doubt, be increased, but to what extent and in what directions only the drill can determine. Within this rectangle all wells which have been driven to as much as 1150 feet have produced oil, while two gas wells not yet producing oil have been struck at a depth of 900 feet. Oil has been encountered in paying quantities in one well at a depth of 760 feet, but this cannot be regarded as the main oil-bearing stratum as numerous minor flows have been struck in several wells at various depths.

"A great number of companies have purchased small tracts of land, some only one-sixteenth of an acre in extent, in the proven territory, and are now putting down wells. In a short time, therefore, the number of producers will be increased. On Spindle Top Heights there are between fifty and sixty derricks, about forty of which are being or have been used in the actual process of drilling. All these, however, are not in the proved territory. While it is impossible to state the exact figures, it has been estimated that there have been 300 derricks erected in Jefferson county, less than half of which have been operated.

"Dry holes are numerous outside of the proven field. These wells vary in depth from 1200 to 2200 feet. It has been claimed that a number of wells have not been producers because the oil has been cased off. This is possible, but not at all probable. It is surprising that no deep test wells have been put down in parts of the territory not immediately contiguous to the producing district. This method would certainly be more economical than the present practice of drilling a number of dry holes on adjacent lots.

"Though its topography would indicate that Spindle Top is an anticline and, therefore, furnishes favorable conditions for the accumulation of gas and petroleum it does not necessarily follow that these products will be found only on this or similar ridges. Anti-clines or mono-clines may be present, whose existence is entirely hidden by the surface deposits of sandy or clayey nature characteristic of the coastal plain. These considerations make it all the more evident that exploration by means of the drill is the court of last resort in the determination of the absence or presence of oil in this region. The conditions for the formation of oil and sulphur have been similar over the whole of the coastal plain, but the conditions favorable to accumulation are the most important features to the producer.

"The presence of 'gas pockets' seems to be well established in this district. In at least two instances strong flows of gas have been encountered, unaccompanied by oil. The most notable of these was the Guffey Co.'s well struck on June 27th, which discharged gas and mud at an enormous pressure and with great force for over six hours, when it ceased flowing of its own accord. From this well 400 feet of 4-inch casing was blown clear of the hole by the force of the escaping gas.

"In the oil producing wells more or less gas is always encountered in association with the oil or alone. It is noteworthy that at Sour Lake, Hardin county, mud and gas were struck at a depth of 900 feet, which is practically the same distance below the surface at which the Beaumont flows were encountered. Gas has also been reported in a number of the dry holes.

"Practically all the wells bored in the Beaumont district have been sunk by means of the rotary system of drilling. This method is considered to be better adapted to the conditions in the field than the cable rig drill on account of the large bodies of sand and clay and the small number of hard strata encountered. The depths at which oil is found make the use of the rotary entirely practicable. The wells are generally begun with pipe having a diameter from eight to twelve inches, which is reduced as the depth increases. Up to July 1st the largest size actually tapping the lower oil rock was a 6-inch pipe, while a number of the wells are four inch, and at least one gusher three and one-fourth inch. The first oil ever reached in the district was with a one and one-half inch pipe at a depth of 482 feet. This was in the well drilled by Capt. Lucas previous to bringing in his 'gusher.'

"As to the rate of drilling it may be stated that in a great measure it depends on circumstances. On the whole, however, it is surprising that, with the section encountered, the work should be so slow, especially as experience has been gained in the field. The Lucas gusher was begun October 27, 1900, and was completed January 10, 1901, consuming, therefore, seventy-five days in drilling. The Beatty well, belonging to the National Oil and Pipe Line Co., was begun February 12, 1901, and was completed on March 26th, consuming forty-two days. The Heywood No. 3 was started May 3rd and finished May 24th, consuming twenty-one days, which is so far the best record for an oil-producing well. The first mud gusher struck by the Guffey Co. was drilled 900 feet in nine days, which is the best rate of boring in this field.

"The cost of drilling in the Beaumont field has been subject to great variation. The work is practically all done by contract, the driller agreeing to go to the desired depth at a given rate per foot, the well owner furnishing pipe for casing, etc. In case of accident or abandonment of a well the drillers are the losers, though the owners may suffer the loss of the casing. The prices now prevailing vary from $2.50 to $8.00 per foot, according to the location, although wells have been drilled at the rate of more than $10.00. The average on Spindle Top Heights is about $3.00; the owners furnishing fuel and water.

"When it is taken into consideration that only six months have elapsed since the field was opened it is remarkable what progress has been made in the equipment of necessary plants for the handling of the output of the wells. A pipe line has already been completed to tide water at Port Arthur and two more are under process of contruction, one to Sabine Pass and the other to Port Arthur. A six inch line has been laid from Spindle Top to the city of Beaumont and stations at Gladys City and Stribling are connected by pipe lines with the field. At these stations extensive loading racks for tank cars have been constructed. Loading racks have also been finished in Beaumont. Most of the pipe lines are six inch, though the racks are supplied with four inch feeders. The pipe line owned and operated by the Guffey Co. from Spindle Top to Port Arthur is about twenty-two miles in length. A pumping station is located near the wells and at El Vista, five miles northwest of Port Arthur, are five storage tanks of 50,000 barrels capacity, each. From El Vista to the docks at Port Arthur the pipe line is ten inches in diameter. The cost of the pipe lines vary from $5,000 to $10,000 per mile, according to size, depth below the ground, etc. In some instances pipes have been laid upon the surface. Up to the present, tanks having an aggregate capacity of from 600,000 to 700,00 barrels have been constructed. Contracts have been let, however, for a total tankage of almost 4,000,000 barrels, one company alone having 2,000,000. The standard size petroleum tank is of 37,000 barrels capacity, but nearly all the tanks in the Beaumont region are built in 50,000 barrels sizes, and two of 115,000 barrels capacity, each, have been projected. Four tank building concerns are in the field, and have contracts that will keep them in operation for over two years. The tanks are being built at various convenient points in the field, such as Gladys City, Spindle Top, Beaumont and Sabine Pass, but Port Arthur will be the distributing point for the largest producers. The cost of building the large size tanks is about twenty-two cents per barrel capacity, and on this basis it is estimated that one filling of the tank with oil will pay for the cost of construction of the tank. About 500 tank cars are now operating in the field, all the companies owning or leasing a considerable number. A large portion of the product must necessarily be handled by this method, especially that intended for inland fuel consumption. At present a considerable quantity of oil is being shipped by this means, the maximum amount so far reached being 150 cars per day. These tank cars have a capacity varying from 6500 to 8000 gallons. The Beaumont field is very advantageously situated for the shipment and distribution of petroleum, whether by rail or sea. The Southern Pacific and the Kansas City Southern penetrate the field, and other roads are in process of construction.

"For Northern and Eastern markets the most advantageous rates for handling the oil are obtained through tank steamers and barges. The pipe lines and railroads deliver the oil at tide water, Sabine Pass, thirty-two miles from Beaumont, which is at the head of the channel connecting Sabine Lake with the Gulf. This lake, which is unfortunately very shallow, being only eight feet at its deepest part, is connected with Sabine Pass by a ship canal seven and one-half miles long, 180 feet wide at the top, 100 feet at the bottom and twenty-five feet deep. The docks at Port Arthur, the lake end of the canal, are capable of accomodating vessels of large size. The largest vessel to ascend the canal, so far, had a tonnage of 3190. A project is on foot to extend the ship canal to the mouth of the Neches river, or to dredge a channel through the lake. But there seems to be no likelihood of this work being done soon.

"Sabine Pass was the shipping point for 97,376 barrels of petroleum last year, before oil was discovered in the Beaumont district. J. S. Cullinan & Co., of Corsicana, have a storage tank of 37,000 barrels capacity from which the oil was drawn and sent by water to Philadelphia. When the pipe line is completed to Sabine Pass and the contemplated storage tanks are finished the amount of oil handled will be very largely increased.

"The first oil shipment to leave Port Arthur was on March 22nd of this year when the *Atlas*, a tank steamer belonging to the Standard Oil Co., carried a cargo of 3000 barrels to Philadelphia for experimental purposes. Two months later this same steamer with barge 81 cleared from Port Arthur with a cargo of 32,000 barrels of fuel oil. Shipments will be made in the future as rapidly as vessels can be secured. A fleet of tank steamers will, in all likelihood, be built to supply the demand for export and coast-wise trade.

"The physical and chemical nature of the oil will be discussed elsewhere. That it is capable of being refined may be gathered from the fact that several refineries are now under way and others are projected. Two belonging to one of the producing companies are being erected at Port Arthur, while independent refineries may be looked for in the future.

"While as yet the capacity is far in excess of the market it may be stated that the daily sales are increasing rapidly, a fact no doubt due to the installment of oil burning engines where they are profitable. One company has been marketing 5000 barrels a day for over a month, and contracts with fuel consumers have already been entered into that will increase this amount very largely.

"As to the actual capacity of the field it is impossible to give any very exact estimate. It is possible that as the number of wells is increased the production per well will be greatly diminished and that in the course of time they will cease to be 'gushers' and become pumpers. This has been and will continue to be the history of oil fields, though it is of course impossible to give even an approximate life period to the field. It may be stated, however, that large initial productions do not necessarily indicate longevity. The enormous capacities claimed for some of the wells do not seem to have been based on reliable data, being, at best, guesses. Rates of flow into tanks have been measured for short periods of time and the results thus obtained would indicate that, while the outputs are very large, they are really not so extraordinary as has been claimed. Flowing wells with capacities less than 5000 barrels per day are not unknown in the field.

"The cost of petroleum will, of course, fluctuate according to market conditions. It is now (July) being sold at from twenty to forty cents per barrel of forty-two gallons, on board the cars at Beaumont. It is doubtful whether this price can be maintained, but even at half this price the revenue from the sale of oil produced will be very large. In some instances five-year contracts have been made to furnish large quantities of fuel oil at prices considerably less than those mentioned above.

"Of the great number of companies operating in the field the majority have leases on their territory, though a number of the important companies own ground in fee simple. The regulation oil lease runs for twenty years, but carries a clause permitting the operator to have the benefit of the land so long as oil in paying quantities shall be found. All leases carry royalties, which vary in amount from an eighth to a twelfth of the oil produced, but one large producing company has a lease which carries fifty per cent. on the gross production.

"It has not been the custom for some of the drillers to keep accurate logs of the wells bored. To obtain reliable logs with the rotary system of drilling it is necessary to have watchers stationed at the derrick constantly in order that all the samples of the strata penetrated may be obtained and compared. A few points concerning the wells of the Guffey Company are, however, given herewith. The wells are named according to the tracts of land upon which they have been bored. The Lucas gusher under this system being McFadden No. 1.

"Gladys No. 1 was started with an 8-inch hole and brought in with a four inch. The well went to a total depth of 1070 feet. The section was composed largely of sand, but at 600 feet considerable rock was encountered.

"Gladys No. 2 started with a 10-inch casing and was completed with a 6-inch. Its total depth was 1092 feet, though oil was struck at 1042 feet. After the oil was struck the well was drilled fifty-two feet deeper with the cable rig. About seventy feet of sulphur was encountered in this well.

"Gladys No. 3 is a shallow well, being only 760 feet to the oil, which was tapped with an 8-inch pipe, the largest size casing actually tapping the oil in the field. The flow, however, is not strong, and the oil is regarded as belonging to the same horizon as that struck in the first Lucas well, bored west of the Lucas 'gusher.'

"McFadden No. 2 was drilled down 910 feet when gas and mud were encountered and the well lost. The drill rig was moved and a new No. 2 with a good flow of oil was brought in at 917 feet.

"In McFadden No. 3 the oil rock was reached at 1028 feet with a 6-inch casing. Sulphur was encountered at various depths in this well.

"McFadden No. 4 was a gas well. The gas was tapped on June 27th at a depth of 918 feet. No sign of oil accompanied the flow. After spouting clay, sand, mud and gas for six hours the well ceased operation, which would indicate that after the gas pocket was exhausted the well had plugged itself. This well had been over two months in drilling and hard rock had been encountered.

"The well owned by the Hogg-Swayne Syndicate was started by the Guffey Company. Oil was drilled in at 1060 feet and the flow was struck with a 3½-inch casing.

"Six wells are now being put down by the Guffey Company in the immediate vicinity of Spindle Top.

"The discovery of oil at Beaumont has caused great and widespread interest, not only in Texas, but over the whole United States. Companies have been formed in almost every State in the Union and numerous foreign companies have been organized with the intention of operating in this field.

"Up to the present time over 400 companies, with a total capitalization of almost $200,000,000, have been chartered. The capital stock of the companies varies from $5,000 to $15,000,000, $100,000 being the most common amount. A company to develop both oil and lumber has recently been organized, having a capitalization of $30,000,000. A great number have already gone out of existence and many, though still nominally in existence, are to all intents and purposes, defunct. The public has been educated and it is now necessary to have something more than a high sounding name for a company to sell stock, as a spirit of conservatism, the natural reaction from the feverish speculation, prevails.

"Speculation in lands and leases has been actively carried on and enormous prices have been paid for land in the vicinity of Spindle Top Heights. Small plots of land have been sold at the rate of $100,000 an acre, and barren lands at considerable distance from the center of operations have been sold for prices which were from five to one hundred times their value before the discovery of oil. These inflated values were the result of an unprecedented 'boom,' and of course were only temporary. The discovery of oil in a new locality would hardly cause a repetition of such excitement, which, at best, retards the legitimate development of the oil industry."

LOG OF THE LUCAS WELL, THE FIRST ONE TO STRIKE OIL IN DEPTH, NEAR BEAUMONT, TEXAS. BEGUN OCTOBER 27, 1900; COMPLETED JANUARY 10, 1901. TIME, 75 DAYS.

From—	To—	Made feet.	Formation.
0	36	36	Yellow clay.
36	56	20	Coarse gray sand.
56	170	114	Blue clay, pretty hard.
170	245	75	Fine gray sand.
245	265	20	Variously colored gravel, from bean to goose-egg size.
265	317	52	Coarse gray sand.
317	352	35	Blue clay.
352	376	24	Coarse gray sand, with pyrite concretions.
376	395	19	Blue clay.
395	460	65	Fine gray sand, with lignite.
460	465	5	Marl.
465	505	40	Gray sand, with concretions and much lignite.
505	505.75	0.75	Soft limestone.
505.75	525.25	19.50	Gray clay and sulphuretted hydrogen gas.
525.25	526	0.75	Hard sandstone, with calcite depositions.
526	557	31	Gray sand.
557	582	25	Compact hard sand, with pyrite.
582	582.5	0.5	Hard sandstone and calcareous concretions.
582.5	595.75	13.25	Gray clay.
595.75	597	1.25	Hard sand.
597	654	57	Gray clay, with calcareous concretions.
654	660	6	White, calcareous shells.
660	674	14	Gray clay.
674	680	6	Gray sandstone, with oil.
680	687	7	Gray clay, with calcareous concretions.
687	715	28	Gray clay; getting harder.
715	717	2	Calcareous concretions with calcite.
717	832	115	Hard gray clay with calcareous concretions; much fine pyrite.
832	852	20	Hard gray clay with calcareous concretions; much fine pyrite.
852	872	20	Sandstone and pyrite; hard.
872	875	3	Hard rock, apparently limestone.
875	899	24	Fine oil sand, with large layer toward bottom and heavy pressure under it, filling casing for 100 feet above point of drilling.
899	979	80	Hard clay.
979	1029	50	Calcareous concretions, with layers of hard sandstone.
1029	1069	40	Struck heavy gas pressure and oil, which lasted about one hour and then subsided.
1069	1139	70	Sand mixed with calcareous concretions and fossils.

NOTE.—Instead of using the log of this well as given by Mr. Lucas in the Trans. Amer. Inst. Min. Engrs., which contains some typographical errors, we have used the corrected log published, by permission, by the Beaumont Engineering Co., and received from them July 1st.

Oil was tapped at a depth of 1120 to 1139 feet, and the 4-inch pipe used in drilling was shot out of the well, carrying block and tackle with it.

In the log of the Lucas well no mention is made of quicksand, but in the Beatty well, half a mile to the north, it was struck in the interval 170 to 350, again in the interval 420 to 530, again in the interval 580 to 615, again in the interval 637 to 840, and in the interval 855 to 934. It is known that quicksand was encountered in the Lucas well and, indeed, in all the wells bored in the Beaumont district, and its omission from the log of the Lucas well must be attributed to a pardonable oversight. It may be accounted for by the fact that all drillers do not agree as to the nature of quicksand and what is such to some of them would not be so termed by others.

It is noticeable that in the Lucas well the first appearance of an oil-bearing horizon was in the interval 679 to 685, while the first appearance of the oil sand in the Beatty well was in the interval 570 to 580. In the Lucas well there was an oil sand in the interval 875 to 899 feet, but none in the Beatty well at this depth or within any moderate approximation to it. The first oil struck in the Lucas well, viz., in the interval 875 to 899, was somewhat heavier than the oil found at the bottom. Following is an analysis by Mr. E. P. Schoch, of The University of Texas, of a sample of the upper oil:

ANALYSIS OF OIL FROM THE INTERVAL 875 TO 899 FEET, LUCAS WELL.

Specific gravity at 60° F. 0.9818 (22° B.).
Fractions, ordinary distillation. Scarcely any distillate up to 212° F.

Degrees F.	Per cent. of yield by Vol.	Color.
212 to 320	1.98	Clear white.
320 to 410	5.07	Light straw yellow.
410 to 464	14.60	Deeper straw yellow.
464 to 500	8.98	Deep yellow.
500 to 600	[illegible]	Light red brown.
Above 600	37.08	Dark brown; fluorescent.
Residue	2.52	
Loss	2.56	
	100.00	

By comparing this analysis with the one given on page 70, and which represents the Lucas oil from the bottom of the boring, i. e., from a depth of 1120 to 1139 feet, it will be seen that while they are practically the same as regards the amounts of the distillates up to 400° F., above this point they begin to diverge. Perhaps the divergence is not enough to warrant the assertion that the two oils are radically different, but the differences between them are noticeable. This is, perhaps, the only analysis of the upper oil that is now available. The flow was not considered strong enough to justify the stopping of the boring at that point so it was continued to 1139 feet. The log of the Higgins well, which is located about 600 feet west of the Lucas well, shows that the first oil was found at 536 feet, but the heavy flow came from a depth of 1030 to 1040 feet.

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ANALYSIS OF CRUDE OIL FROM THE LUCAS WELL, BEAUMONT, JANUARY 25, 1901, FROM DEPTH OF 1120 TO 1139 FEET.

E. P. Schoch, The University of Texas.

Specific gravity at 60° F. 0.916 equals 23° B.
Fractions, ordinary distillation without reduction of pressure.

Degrees F.	Per cent. of yield by vol.	Color.
212 to 320	1.79	Clear white.
320 to 410	6.41	Light straw yellow.
410 to 464	8.86	Deeper straw yellow.
464 to 500	12.14	Deep yellow.
500 to 600	15.65	Light red brown.
Above 600	44.84	Dark brown; fluorescent.
Residue	4.21	
Loss	5.26	
	100.00	

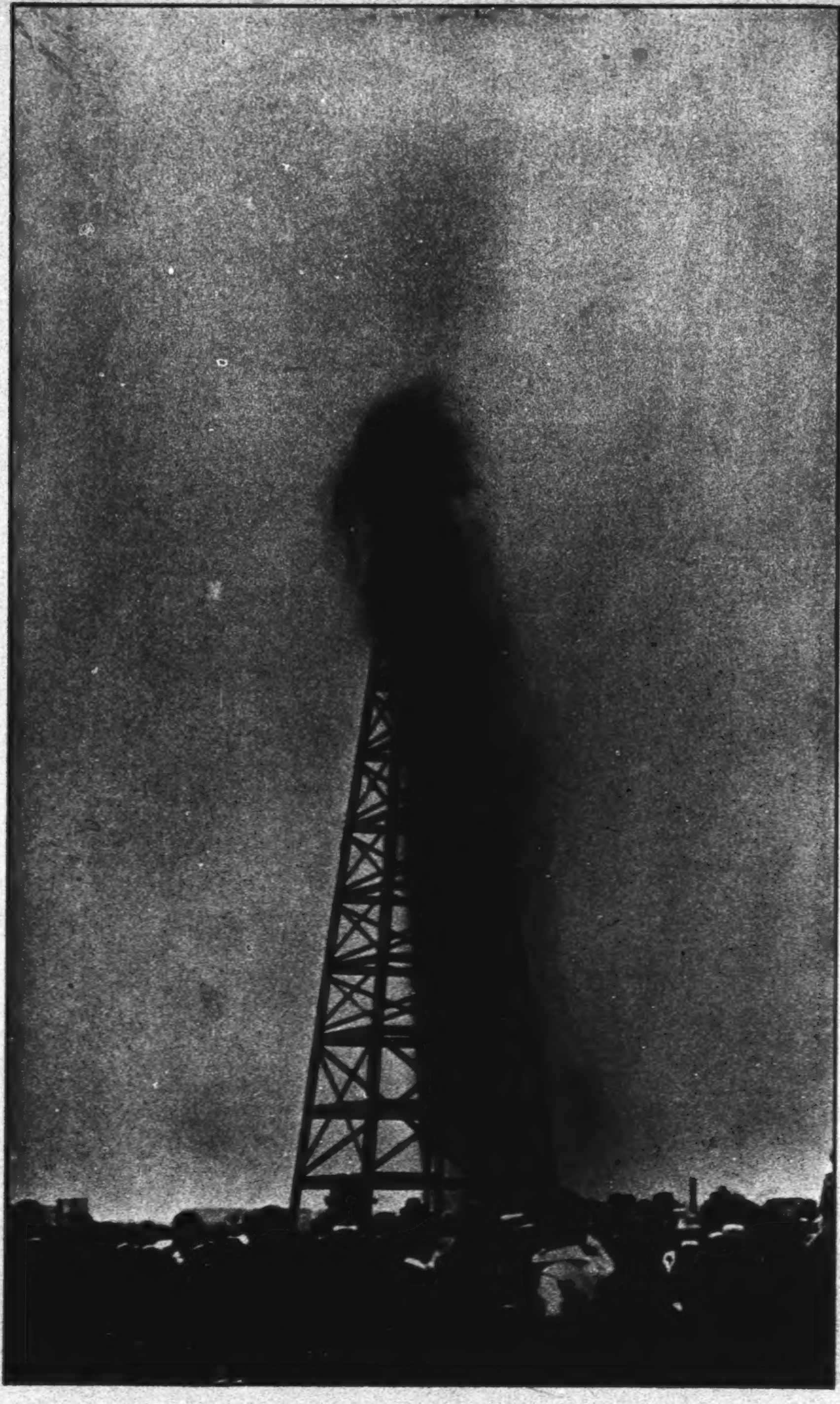
NOTE.—At 311° F. a white sublimate appeared in the condenser, probably sulphur. At 383° F. sulphuretted hydrogen fumes were quite strong. From 572° to 662° F. scarcely any distillate.

This was one of the first analyses made of this oil and the results have been confirmed by many analyses made since that time.

LOG OF THE NATIONAL OIL AND PIPE LINE CO.'S WELL NO. 1 (BEATTY), NEAR BEAUMONT, TEXAS. BEGUN FEBRUARY 12, 1901; COMPLETED MARCH 26, 1901. TIME, 42 DAYS.

From—	To—	Made feet.	Formation.
0	170	170	Clay.
170	350	180	Quicksand.
350	420	70	Blue clay.
420	530	110	Quicksand.
530	533	3	Limestone.
533	570	37	Blue clay, or marl.
570	580	10	Oil sand.
580	615	35	Quicksand.
615	630	15	Shell rock. Concretion of sea shells.
630	637	7	Oil sand.
637	840	203	Quicksand.
840	855	15	Lime and sand stone.
855	934	79	Quicksand and clay.
934	938	4	Hard lime rock.
938	978	40	Pure sulphur (rock).
978	1016	38	Oil sand and sulphur.

The well is cased for 360 feet down with 12-inch pipe, inside of which is an 8-inch pipe which extends down 654 feet. Inside the 8-inch pipe there is a 6-inch pipe, which extends down to 936 feet and is firmly bedded in the lime rock at that depth. This rock has a hole bored in it six inches in diameter and twenty-eight feet deep, down to the 1018 foot level.



THE HIGGINS OIL & FUEL CO. WELL NO. 1.

LOG OF THE HIGGINS WELL NO. 1, BEAUMONT. BEGUN JANUARY 31, 1901; COMPLETED MARCH 25, 1901. TIME, 53 DAYS.

Three feet of black loam at surface.

From—	To—	Made feet.	Formation.
3	30	27	Blue clay.
30	51	21	Quicksand and very fine sand.
51	80	29	Fine sand mixed with clay.
80	100	20	Fine sand mixed with very fine clay.
100	110	10	Sand as fine as flour.
110	120	10	Fine sand.
120	140	20	Clay, sand and stone.
140	160	20	Fine sand and brackish water.
160	170	10	Blue clay.
170	180	10	Coarse sand.
180	200	20	Coarser sand.
200	225	25	Medium fine sand.
225	245	20	A little finer sand.
245	260	15	Coarser sand, with black pebbles.
260	280	20	Still coarser sand.
280	360	80	Coarse sand mixed with clay.
360	365	5	Coarse sand, no clay.
365	380	15	Coarser sand.
380	395	15	Very coarse sand.
395	418	23	Coarse sand, with black pebbles and shells.
418	425	7	Sharp, finer sand and shells.
425	445	20	Blue sand, still finer.
445	460	15	Coarse sand.
460	490	30	Sharp sand, coarse shells.
490	515	25	Sharp sand, coarser shells.
515	536	21	First sign of oil.
536	556	20	No oil; coarse sand and shells.
556	575	19	Coarse sand with black pebbles. Struck more oil than at 515.
575	595	20	Very fine blue sand; no oil.
595	615	20	Coarser sand, some shells.
615	700	85	Coarser sand and siliceous pebbles.
700	785	85	Very coarse blue shells.
785	805	20	Finer shells; some blue clay.
805	825	20	Clayey sand; numerous shells.
825	845	20	Sand; some shells.
845	875	30	Blue sand; some shells.
875	900	25	Little finer sand; some shells.
900	920	20	Yellow sand; fairly good signs of oil, which settled on water.
920	940	20	No oil; medium fine sand.
940	945	5	Blue shale; some shells.
945	960	15	Blue shale; no shells.
960	980	20	Darker sand, with trace of oil.
980	1,000	20	Lighter colored sand; blue shale; trace of oil.
1,000	1,020	20	Blue shale; trace of oil, and a barrel of oil baled in two days.
1,020	1,030	10	Oil bearing rock.
1,030	1,040	10	Sulphur and rock.

ANALYSIS OF OIL FROM HIGGINS OIL AND FUEL CO. BEAUMONT.

O. H. Palm.

Fractions.—Degrees F.	Per cent. by Vol.	Specific Gravity	Color.
84.2 to 212	....	....	
212 to 257	....	....	
257 to 302	2.9	0.7958	Colorless.
302 to 347	2.4	0.8275	Colorless.
347 to 392	1.1	....	Colorless.
392 to 437	3.1	0.8587	Pale amber.
437 to 482	6.2	0.8680	Pale amber.
482 to 527	11.5	0.8748	Straw yellow.
527 to 572	15.2	0.8797	Straw yellow.
572 to 617	5.8	0.8867	Straw yellow.
Above 617	35.8	0.9064	Reddish brown.
Residue	7.8	....	Coke and Asphalt.
Loss	7.9		
Total	99.9		

Sulphur, 2.4 per cent.

Color of crude oil, reddish brown.

Flash point, 120° F.

Specific gravity at 82.4° F., 0.9103 (24° B.).

Naphtha fractions, 2.9 per cent. by vol.; burning oil 39.8 per cent.; heavy oil, 42.6 per cent.

British Thermal Units, 19,785,

LOG OF HEYWOOD NO. 2. BEGUN MAY 1, 1901; COMPLETED MAY 25, 1901; TIME, 25 DAYS. SIX-INCH PIPE.

From—	To—	Made feet.	Formation.
Surface	15	15	Red clay.
15	25	10	Fine sand.
25	60	35	Blue clay.
60	75	15	Sand.
75	120	45	Blue clay.
120	130	10	Sand.
130	180	50	Clay.
180	[illegible]	300	Sand.
[illegible]	510	30	Clay.
510	[illegible]	16	Sand.
[illegible]	[illegible]	1	Rock.
[illegible]	[illegible]	65	Sand.
[illegible]	[illegible]	28	Rock in small layers, clay between.
[illegible]	[illegible]	11	Clay.
[illegible]	[illegible]	5	Rock.
[illegible]	[illegible]	22	Clay.
[illegible]	[illegible]	3	Rock.
[illegible]	[illegible]	17	Clay.
[illegible]	[illegible]	19	Sand.
[illegible]	694	4	Rock.
[illegible]	735	41	Clay.
735	740	5	Rock.
740	[illegible]	43	Clay.
[illegible]	[illegible]	6	Rock.
[illegible]	[illegible]	44	Sand.
[illegible]	[illegible]	2	Rock.
[illegible]	875	40	Clay.
875	876	1	Rock.
876	[illegible]	20	Sand.
[illegible]	917	34	Clay.
917	[illegible]	23	Sulphur Rock.
[illegible]	[illegible]	17	Oil sand.
		[illegible]	

HEYWOOD OIL CO. WELL NO. 2.

STAR AND CRESCENT WELL.

LOG OF HEYWOOD NO. 3, NEAR BEAUMONT, TEXAS. BEGUN JUNE 3, 1901; COMPLETED JUNE 24, 1901. TIME, 21 DAYS.

From—	To—	Made feet.	Formation.
Surface	16	16	Yellow Clay.
16	26	10	Sand.
26	60	34	Blue clay.
60	78	18	Sand.
78	180	102	Blue clay.
180	350	170	Sand.
350	480	130	Clay and sand.
480	530	50	Rock.
530	560	30	Clay.
560	595	35	Sand.
595	740	145	Clay.
740	780	40	Sand.
780	812	32	Clay.
812	822	10	Sand.
822	842	20	Clay.
842	852	10	Sulphur rock with oil signs.
852	872	20	Sand.
872	887	15	Sulphur rock.
887	897	10	Sand.
897	905	8	Sulphur rock.
905	907	2	Sand.
907	927	20	Sulphur rock.
927	935	8	Loose oil sand.
		935	

ANALYSIS OF BEAUMONT CRUDE OIL, MADE BY PROF. L. W. WILKINSON, TULANE UNIVERSITY, NEW ORLEANS.

Specific gravity, 0.912.

Fractions.—Degrees F.	Distillation. Atmospheric Pressure.	Fractions.—Degrees F.	Distillation. Atmospheric Pressure.
	Per cent. by volume.		Per cent. by volume.
374	2.00	536	24.40
392	3.12	554	30.10
410	4.40	572	33.70
428	5.00	590	36.90
446	[illegible]	608	[illegible]
464	[illegible]	626	[illegible]
482	11.30	644	[illegible]
500	15.60	662	[illegible]
518	19.40	680	41.20

Commenting on these results, Prof. Wilkinson says:

"From the above results it will be seen that at 590° F. the distillate from the crude Beaumont oil amounted to 36.90 per cent by volume. In refining the Pennsylvania oil that part distilling over between 302° and 572° F. is usually considered as illuminating oil, and it amounts to 25 to 38 per cent. of the crude oil. Thus it will be seen that the Beaumont oil at a temperature of 572° F. yields practically the same amount of illuminating oil as the Pennsylvania oil. Continuing the heating to 680° F. the Beaumont oil yielded 41.2 per cent. That part of the Beaumont oil distilling over at 572° F. was of a light yellowish or straw color, emitting an extremely unpleasant odor and yielded, on refining, about 30 per cent. of the crude oil, and had a density of 0.851 and a flash point of 151° F.

"About 40 per cent of the Beaumont oil distills over above 680° F. and has very little viscosity. The general appearance of the higher oils indicates that the process of 'cracking' would cause a large part of the higher oils to pass into the lower or illuminating oils."

Prof. Wilkinson thought that from 30 to 40 per cent. of illuminating oil of good quality could be obtained from Beaumont crude oil, and that by the "cracking" process a yield of 50 per cent. or more could be obtained.

Prof. Wilkinson's results are not in accord with analyses made elsewhere, as the following extract from a paper communicated by Mr. A. F. Lucas to the American Institute of Mining Engineers will show. The analysis was made by Mr. A. M. Smoot, chief chemist in the establishment of Ledoux & Co., 99 John St., N. Y. The results are as follows, the sample being that of crude Beaumont oil from the first or Lucas well.

"ANALYSIS OF CRUDE BEAUMONT OIL. A. M. SMOOT. LEDOUX & CO.

"Specific gravity at 60° F. 0.925 (21.5° B.).
"Distillation according to Engler's specifications.
"Distillation began at 302° F.

Degrees F.	Per cent. by volume.	Sp. Grav.	Degrees F.	Per cent. by volume.	Sp. Grav.
302 to 392	4.0	[illegible]	572 to 662	[illegible]	0.916
392 to 482	12.50	[illegible]	Residue and loss	2.5	
482 to 572	28.0	[illegible]			

"The crude oil contains 2.04 per cent. of sulphur.

"It will be seen that the specific gravity of the Beaumont oil is far higher than that of oils which yield notable quantities of illuminants. * * * The Beaumont oil is very high in sulphur. Lima oil, the best known of the sulphury oils, is stated by Mabery and Smith to contain 0.55 per cent. of sulphur. Redwood gives the sulphur in a sample of Canadian oil as 0.98 per cent. The oils of Alsace are said by the same authority to contain from 0.134 to 0.138 per cent., and those of Peine (Hanover) from 0.077 to 0.085 per cent. * * * Consideration of the distillation figures obtained from the Beaumont oil shows at once that the sample is not at all comparable with Ohio or Pennsylvania oils as to the yield of illuminating oil. * * * In examining the Pennsylvania and Ohio oils it is customary to regard the fraction distilling between 302° and 572° F. as burning oil. Some of the heavy Russian oils yield illuminants only up to 545° F. The fractions obtained from the Beaumont oil between 302° and 572° F. are much heavier even than the Russian. This is shown by comparison with the following table of the gravities of burning oils, taken from Redwood:

	Boiling point 302° to 572° F.
Kaiser oil	0.780 to 0.800
American Illuminating oil	0.800 to 0.810
Russian Illuminating oil	0.820 to 0.825
Standard White oil	0.808 to 0.812
Prime White oil	0.800 to 0.806
Astraline	0.850 to 0.860

"No considerable fraction of the Beaumont oil has a gravity less than 0.867, the greater part of the portion distilling under 572° F. has an average gravity of 0.886. It, therefore, does not seem likely that the Beaumont oil will yield a desirable burning oil by normal distillation. To determine whether or not the 'cracking' process of distillation would yield burning fractions of lower gravity than those obtained by the normal distillation, a sample was treated in a distilling flask of large capacity in proportion to the amount of oil contained in it. The distillation was conducted so that the lighter vapors condensed in large quantities on the cool sides and in the long neck of the flask, running back into the very hot residue. The distillation was conducted slowly, yielding first drop at 197.6° F.

	Per cent. by volume.	Specific gravity.		Per cent. by volume.	Specific gravity.
197.6° to 302° F.	2.1	0.820	482° to 572° F.	21.1	[illegible]
302° to 392° F.	1.9	0.852	Over 572° F.	24.2	[illegible]
392° to 482° F.	21.9	0.875			

"The yield of distillate at a temperature under 572° F. is increased by the 'cracking,' but the specific gravity of the fractions is also increased.

"The conclusions to be drawn from this investigation, as far as it goes, are that the Beaumont oil is very high in sulphur; that it will yield less than ten per cent. of kerosene, probably nearer five per cent., and only limited quantities of very heavy burning oil, similar in specific gravity to Russian Solar oil. The chief application of the Beaumont oil will no doubt be for fuel purposes."

Ledoux & Company say that they have been favored with some other results of the examination of crude Beaumont oil. One sample showed:

"Specific gravity 0.904 equals 25.40° B.

"Flash point, 165° F., in open cup.

"Cold test, not congealed at minus 10° F.

"Viscosity, at 70° F. 96.

"In ten distillates of equal quantity the successive fraction varied in gravity from 0.839 (38° B.) to 0.924 (22° B.), the increase in gravity being fairly regular between these points; the pitch remaining in the still at a melting point of about 300° F. It may be said that this oil seems to have an asphalt base, which simply means that its products do not belong to the paraffin series."

The Emery Manufacturing Company, Bradford, Pa., also examined the product of the Lucas well and reported as follows:

"The Beaumont, Texas, oil is of a dark green color and has an offensive odor, similar to that of Lima and Canadian oils, with the odor of sulphuretted hydrogen more pronounced. The crude oil has a flash test of 110° F. and fire test of 180° F.; the specific gravity at 60° F. is 0.915 (23.6° B.). The oil showed no evidence of congealing at a temperature of 5° F. below zero; this property denotes the absence of paraffin and belongs to a series of oils having an asphaltum base. In order to determine the commercial value of the crude oil it was necessary to subject the sample to fractional distillation. Four gallons of the crude were taken for the process, and the gravity of the first two ounces of distillate that passed through the condenser was 0.753 (58° B.). The gravity of the first eight ounces of distillate obtained was 0.773 (53° B.), and the gravity of the second eight ounces was 0.808 (44.9° B.). Ten one-pint samples of the distillate were obtained, the gravities of which were as follows:

No.	Specific gravity.	Degrees Beaume.	No.	Specific gravity.	Degrees Beaume.
1	0.836	37.9	6	[illegible]	29.2
2	[illegible]	33.1	7	[illegible]	28.6
3	[illegible]	32.6	8	[illegible]	27.6
4	0.872	31.6	9	[illegible]	26.7
5	0.876	30.8	10	[illegible]	25.4

"The first and second eight-ounce samples flashed at the ordinary temperature and would be called benzine, but could not be used in the arts on account of the low gravity, and, on account of the low percentage (1.56 per cent.), the yield would be almost unprofitable to collect separately.

"For the burning oil distillate the first four pint samples were taken, the gravity being 0.859 (34° B.), and the mixture was found to have a flash test of 85° Abel, or about 130° F.

"While this oil would pass the trade requirements in the properties of color and fire test, the gravity and odor are so far from the requirements of a marketable illuminating oil, that under no consideration could it be sold as such, providing the illuminating oils from Pennsylvania, and even Lima crudes, could be obtained.

"The intense odor of the oil would prevent its use as an illuminant, and sulphur in small quantities in crude oil imparts to the distillates a very disagreeable smell, which can only be removed with great difficulty and expense.

"The great bulk of the distillates would be condensed at gravities below 0.880 (30° B.), and on account of its low viscosity could not be used as a lubricant; and assuming the oil has no value as an illuminant and lubricant, it can only be used for fuel, and its terrific odor would prevent its use as a fuel in a thickly populated center.

"From four gallons (thirty-two pints) of Beaumont crude the following percentages of products were obtained:

One-half pint 53° B. benzine (sp. grav. 0.773).	1.56
One-half pint 44.9° B. benzine (sp. grav. 0.808).	1.56
Four pints low gravity and bad smelling illuminating oil, unmarketable..................	12.50
Twenty-five pints fuel oil..................	78.12
Coke and loss..............................	6.26"

The report of the Emery Manufacturing Company certainly makes out a bad case for the Beaumont oil, and if it were true in all respects the large investments that have been made in the district could not hope for much return. With respect to illuminating oils, using the term in its ordinary acceptation, the Beaumont oil is certainly inferior to Pennsylvania oils and even to Lima oils. Its percentage of sulphur is much higher than in either of these oils and the yield of illuminating oil much lower. But while it may not be possible to recover naphtha, benzine, kerosene, etc., with profit, yet there are distillates that will come into large use where these lighter oils are not employed, as, for instance, in mine lamps, torches, etc. Lubricating oils of good quality will be made from the Beaumont crude oil, and fuel oils will also be made. The crude oil will come into direct use on a large scale as a fuel for locomotives, stationary boilers, etc., and the refined product for oil engines.

CHAPTER V.

THE UTILIZATION OF PETROLEUM AS FUEL.

Aside from its value as a source of illuminating and lubricating oils, which need not be discussed now, Texas petroleum is likely to find its chief use as fuel. There is an area within the Corsicana field which can be depended on for illuminating oils, and perhaps some of the more recent developments will reveal the existence of other oils that can be used for such purposes. But granting all this, it would still appear that the main value in the new discoveries is to lie in the direction of fuel oil. Cheap fuel is very much needed in the State and throughout the southwest generally, and it is extremely fortunate that such large supplies of fuel oil have been found. As already mentioned, by far the greater part of the enormous production of petroleum in Russia is used for fuel, the amount going to the refineries not being much above twenty per cent. of the total output. The California oil is used for the same purpose, and the growth of industries depending upon oil for fuel in that State has been remarkable.

Without undertaking any very elaborate discussion of the matter, it may be well to mention certain facts in connection with the use of oil for fuel in order to reach some appreciation of what the new discoveries may mean to us. As already remarked, under the discussion of the nature and origin of petroleum, this is not a technical treatise on petroleum, but an attempt to set forth in plain language and for non-technical people, the principles of the industry. The use of oil in a large way is a new thing here and we may be excused for beginning at the beginning.

In speaking of petroleum as a fuel in even the most cursory way it is necessary to start out with the proper ideas as to the nature of the material we are dealing with, and this was attempted in Chapter I. It now becomes necessary to discuss principles underlying the actual use and to point out some of the means employed to that end.

In classifying fuels and comparing them with each other, there must be some common ground upon which they can meet, some standard by which they can all be measured. We must reduce them to a common denominator, or they can not be compared.

Fuels, whether solid, liquid or gaseous, may be regarded from either of two standpoints, from the standpoint of the absolute amount of heat to be obtained from them, or from the standpoint of the amount of heat that may be obtained from them commercially. The first is the scientific method, the second the so-called practical method. For the purpose of comparing one fuel with another the first method is by far the best, for it does not introduce any elements of a varying nature, such, for instance, as the setting of the boilers, the apparatus used for firing, etc. These variants often affect the result to a marked degree and unless one knows all the conditions under which the test was made, it is impossible for him to compare results. On the other hand, if the absolute amount of heat to be obtained from a fuel by the complete combustion of its ingredients is stated mathematically, it at once becomes possible to compare the figures with those obtained from testing other fuels. If the absolute amount of heat in each case is obtained, then the establishment of a ratio becomes possible, and one particular fuel can be said to be so much better or so much worse than another. By the expression "heat value" is to be understood the amount of heat given out by the combustion of substances under ordinary conditions and without regard to whether all of the heat units contained in it were rendered available. By the term "heat units," however, is to be understood the absolute amount of heat obtainable if all the combustible matter contained in the fuel is oxidized to its highest point, all the carbon being burned to carbonic acid and all the hydrogen to water. In some extreme cases the heat of the combustion of other ingredients, such as sulphur, etc., is to be taken into account, but this is only when scientific accuracy is required.

There are two terms by which the absolute amount of heat obtained by the complete combustion of a fuel is expressed, the British Thermal Unit, and the calorie. The British Thermal Unit, ordinarily written B. T. U., is the amount of heat taken up by a pound of water for each degree Fahrenheit that its temperature is raised, or it is the total weight of the water, in pounds, whose temperature is raised one degree F. by the combustion of one pound of the fuel. This applies to solid and liquid fuels, but with respect to gaseous fuels the combustion of one cubic foot, or 100 cubic feet, is considered.

The British Thermal Unit is used in this country as well as in England, etc. The calorie, used on the continent of Europe, is the heat taken up by one gram of water for each degree Centigrade its temperature is raised. The B. T. U. is 1.8 times larger than the calorie, so that to pass from the B. T. U. to the calorie, one must divide by this factor, i. e., 1.8.

The heat given out by a fuel upon complete combustion can be calculated from its chemical composition, but the results vary from two per cent. above to about two per cent. below the observed heat units from actual tests. Perhaps for ordinary purposes and where scientific accuracy is not required, the calculated and the observed heat units may be taken as the same. This rule holds good for substances of not a very complex nature and may be applied to coal, wood, lignite, peat, oil, etc., where one has to do chiefly with carbon and hydrogen.

The heat units (B. T. U.) of a number of the more common substances are given in the following table taken, for the most part, from Poole (The Calorific Power of Fuels, 1900, p. 198):

HEAT OF COMBUSTION OF SUBSTANCES. B. T. U.

Hydrogen	62,100	Olive oil	17,061
Marsh gas	24,017	Pitch	15,120
Diamond	20,041	Coal (pure and dry)	14,040 to 16,200
Paraffin	19,800	Amorphous carbon	14,647
Petroleum	17,280 to 19,800	Beech charcoal	12,852
Gasoline	19,480	Natural gas*	10,866 to 16,681
Petroleum gas	19,440	Lignite (pure and dry)	10,800 to 12,600
Lubricating oil	19,440	Peat	10,692
Asphalt	17,159	Hard wood	8,550
Cotton seed oil	17,100	Coal gas	7,900 to 12,296
Rape seed oil	17,080	Water gas	4,280 to 5,458

*1000 cubic feet of natural gas are taken as equivalent to 1,380 cubic feet of coal gas, the evaporative power being as 893 to 591.

Perhaps a simpler way of explaining the matter is to consider hydrogen as 100 and compare the others with it. The foregoing table will then be as follows:

Hydrogen	100.0	Olive oil	27.4
Marsh gas	38.7	Pitch	24.3
Diamond	32.3	Coal (pure and dry)	22.6 to 26.1
Paraffin	31.9	Amorphous carbon	23.6
Petroleum	27.8 to 31.9	Beech charcoal	20.7
Gasoline	31.4	Natural gas	17.5 to 26.9
Petroleum gas	31.3	Lignite (pure and dry)	17.4 to 20.3
Lubricating oil	31.3	Peat	17.2
Asphalt	27.6	Hard wood	13.8
Cotton seed oil	27.5	Coal gas	12.9 to 19.8
Rape seed oil	27.5	Water gas	7.0 to 9.0

If we take petroleum as the standard here, and consider it as giving on the average 18,500 heat units, and call it 100 the other common fuels in this table will have the following values:

Petroleum	100.0	Natural gas	58.7 to 90.0
Gasoline	105.3	Lignite	58.4 to 68.1
Petroleum gas	106.1	Peat	57.8
Lubricating oil	106.1	Hard Wood	46.2
Asphalt	92.7	Coal gas	43.2 to 66.3
Pitch	81.7	Water gas	22.8 to 29.5
Coal	75.9 to 87.6		

Objection may be raised in respect to the heat units in natural gas, but this is subject to considerable variation in the B. T. U. per cubic foot, viz., from 592 to 1170. McMillin (Ohio Geol. Survey, Vol. VI, p. 544) states that 1000 cubic feet of natural gas evaporates 893 pounds of water, as against 591 pounds for coal gas, 262 pounds for water gas, and 115 pounds for producer gas.

Investigations made in the laboratory of the Survey by Messrs. O. H. Palm and S. H. Worrel on the heating value of a number of Texas oils gave the following results:

	British Thermal Units.	Calories.
Sour Lake, Hardin Co.	18,362	10,201
Sour Lake, Hardin Co.	18,694	10,305
N. E. Fort Stockton, Pecos Co.	17,387	9,655
Near Dunlay, Medina Co.	16,807	9,372
Dullnig Wells, Bexar Co.	15,356	8,531
Walsh Tract, Bexar Co.	16,518	9,177
Lucas Well, Jefferson Co.	19,574	10,874
Higgins Oil and Fuel Co., Jefferson Co.	19,785	10,992

This list will be extended to include all the oils as rapidly as possible, and it is hoped to publish a special Bulletin on this subject next winter. In a number of petroleums, quoted by Redwood, the calories range from 9,708, in oil from Pechelbronn, to 11,700, in oil from Balakhany, near Baku, Russia. Heavy oil from West Virginia gave 10,180, and heavy oil from Pennsylvania 10,672, almost exactly the same value as Sour Lake oil, Hardin county, Texas.

Gasoline goes to 10,822 calories (19,480 B. T. U.).

The fuels with which petroleum will come into competition in this State are the native coals and lignites, and the coals from Indian Territory, Arkansas, Alabama and New Mexico. The question of the comparative value of these several fuels becomes, therefore, of great importance. How many barrels of oil are to be taken as equivalent to a ton of coal? This question can not be answered positively until all the coals and lignites that are used here have been tested. It is pretty well established that the B. T. U. in petroleum will vary from 17,000 to 20,000, one experiment on Texas petroleum giving 20,110. The value here taken, as already remarked, is 18,500 B. T. U. or 10,277 calories. The scientific investigation of the coals, etc., used here, with respect to their heat units, has, unfortunately, not progressed very far, but from the data to hand it is not thought that on the average the B. T. U. in the coals used here will be above 12,600, if, indeed, above 10,800, and will be taken, for the present, at 11,700. For the lignites a lower value must be taken, and, for the present, this will be 9,900.

Some of the Alabama coals used in this State have 13,500 B. T. U.; good McAlester coal (Indian Territory) may be taken at the same; New Mexico coal at 12,000, and lignite at 9,900. On this basis one barrel of crude petroleum, weighing 320 pounds, net, would be equivalent to 438 pounds of Alabama coal, and the same amount of McAlester coal, 493 pounds of New Mexico coal, and 598 pounds of lignite. A ton, 2000 pounds, of Alabama coal would then be equivalent to 4.56 barrels of petroleum; a ton of McAlester coal to 4.56 barrels; a ton of New Mexico coal to 4.06 barrels, and a ton of lignite to 3.34 barrels. In other words, we would have to use from three and one-third to four and one-half barrels of crude petroleum in order to have as many heat units as from a ton of the best coals and lignites now used in the State.

Some experiments made in California with a view to testing the relative value of the California oil and the coal with which it comes into competition, showed that a ton of Nanaimo coal, giving 12,031 B. T. U., was equivalent to a minimum oil consumption of 3.45 barrels and a maximum consumption of 3.87 barrels. Some recent experiments on Texas petroleum showed it to have 19,160 heat units, and this would be equivalent to 4.29 barrels per ton of Indian Territory coal. In Russia the usual equivalent is 3.12 barrels per ton of coal.

There is considerable variation in the quality of coal offered on the market, and these differences are often observable in coal from the same mine, due, perhaps, to carelessness in mining and handling, and to the absence of rigid inspection. In countries where a good deal of coal is sold on the basis of the heat units it contains, these discrepancies are not so potent or so widespread. Variations in the quality of oil from the same well are by no means so marked as in the case of coal from the same mine. Where the oil from different wells has a somewhat different value in heat units the practice of piping different oils into the same storage tanks tends to advance uniformity, just as in the case of the pig-iron mixer in steel plants with respect to pig iron of varying composition.

The value of oil as compared with coal varies somewhat with the nature of the work to be done. It has been observed, for instance, that in puddling and steel heating furnaces, two and one-half barrels of Los Angeles oil were equivalent to 2000 pounds of Wellington coal from British Columbia, while for steaming purposes it took three barrels of the oil for one ton of the coal. In some establishments in Los Angeles the proportion rose to 3.62 barrels per ton; in others to 3.10. On the Southern Pacific Railway in California, it has been found that four barrels of California oil were equivalent to one ton of Nanaimo, British Columbia, coal. The lowest consumption of oil per ton of coal that the writer has been able to find is two and one-half barrels, while the highest is four barrels. An average ratio can be established only when all the conditions are known, but in a general way it may be said that from three and one-half to four barrels of oil should be equivalent to a ton, 2000 pounds, of good soft coal. The lower figure may be reduced under good practice and with the best appliances to three and one-third barrels, while under bad management, etc., the higher figure may reach four and one-half barrels. The highest *evaporative power* on record gives forty-six pounds of water per pound of oil.

Mr. H. Tweddle (*Engineering and Mining Journal*, N. Y., Vol. LXVIII) has fully set forth the advantages to be derived from the use of liquid fuel, and enumerates them under eleven heads. His remarks were directed chiefly to the use of such fuel on vessels, but may be applied with equal force to almost every kind of manufacturing establishment and to locomotives. The advantages claimed are as follows:

1. Diminished loss of heat up the funnel (or chimney), owing to the clean condition in which the boiler tubes can be kept, and to the smaller amount of air which has to pass through the combustion chamber for a given fuel consumption.
2. A more equal distribution of heat in the combustion chamber, as the doors do not have to be opened and, consequently, a higher efficiency is obtained; unequal strains on the boiler tubes, etc., due to unequal heating, are also avoided.
3. With oil there is no danger of having dirty fires on a hard run.
4. A reduction in the cost of handling fuel, as this is done mechanically or by gravitation.
5. No firing tools or grate bars are necessary, consequently the furnace lining, brick work, etc., lasts longer.
6. Absence of dust, ashes, and clinkers.
7. Petroleum does not deteriorate on storing, while coal does, especially soft coal.
8. Ease with which the fire can be regulated from a low to a most intense heat in a short time.
9. Lessening of the amount of manual labor in stoking.
10. Great increase of steaming capacity, the difference being as much as thirty-five per cent in favor of oil.

The eleventh point made by Mr. Tweddle is that of the absence of sulphur or other impurities and longer life to plates, etc. But considering the fact that the amount of sulphur in some of the oils now being used as fuel is in excess of the sulphur in ordinary coals this point is not well taken. Sulphur is objectionable in any fuel, whether coal or oil, and of the two may be more objectionable in oil than in coal, for a portion of the sulphur in coal remains in the ashes and is not consumed.

If crude petroleum, or the residue from refining plants is to come into use on a large scale as fuel, there are some considerations that must be weighed, in addition to its fuel value, viz., its initial price, f. o. b. tanks, or wells, transportation charges, and the like. If a certain freight rate per ton-mile is established for coal and it is sought to establish a rate for oil, why should there not be some standard of fuel value to which both are to be referred? Some coals are better than others, some oils are better than others. In the one case it may require four and one-half barrels of oil to equal a ton of coal as fuel, in the other case the ratio may be much less. If the coal has a high heating value manifestly it will require a larger amount of oil to balance it than if the coal has a low heating value. Perhaps the times are not ripe for the fixation of freight rates based on heat units, but the plan certainly has much to commend it. It may come in with the purchase of fuel on a similar basis, but we are not likely to see either very soon. A ton of coal (quality not specified) will still be taken as equivalent to so many barrels of oil (quality not specified).

Profiting by the experiences in California and elsewhere in the use of oil for fuel, many industrial establishments in Texas have changed or are about to change from coal to oil. Among the first to adopt the new fuel was the American Brewery, Houston. This establishment has a battery of four boilers, two 200-horse power and two 350-horse power. The oil used was the residue from the refining plant at Corsicana, and it was estimated that seventy-five barrels a day would be required, inasmuch as the coal consumption was about twenty-five tons a day. After running for a while it was stated that the steaming capacity of the two 200-horse power boilers using oil was equivalent to the steaming capacity of the two 350-horse power boilers using coal, and that the saving due to the use of oil was about thirty-three per cent. The Star Flour Mills, Galveston, also installed oil burners, about the last of April, using thirty-five barrels a day for a 350-horse power engine. At Gonzales, the Sunset Brick and Tile Co. put in oil burners for a large brick kiln the latter part of May. At Brenham oil burners were installed for the large plant of boilers used by the ice factory, oil mill and electric light works. The Hutchins Hotel, Houston, changed from coal to oil, the battery consisting of two 100-horse-power boilers. The Magnolia Brewery, Houston; the Houston Electric Street Railway, and the City Brewery, San Antonio, changed from coal to oil, and many other plants in the State have the matter under consideration.

The first locomotive equipped for burning oil was delivered to the Gulf, Beaumont & Kansas City Railway June 20th, and belonged to the Gulf, Colorado & Santa Fe Railway. It was No. 065 and pulled a passenger train out of Beaumont June 21st. Up to the time of its reaching Beaumont it had traveled 450 miles and had consumed forty-two barrels of oils, the tank having this capacity. The Southern Pacific Railway is to burn oil west of El Paso, but it is said that California oil will be used. This road has had a greater experience in the use of oil for locomotives than any other railway in the country and when the arrangements are made for burning oil between El Paso and Los Angeles, a distance of about 800 miles, this road will be equipped with oil-burning locomotives from El Paso to Portland, Oregon, a distance of more than 1700 miles.

A large consumption of oil for fuel purposes may be anticipated, especially on the part of the railroads and industrial establishments and the competition of the new fuel with coal will certainly make itself felt. Already some of the railroads bringing coal into the lower Mississippi Valley from Alabama have made sweeping reductions in freight rates in order to meet oil at New Orleans, etc. These reductions amount to about one-half of the former rates. What will be the effect upon the coal trade of this competition? It is, perhaps, too early yet to express a positive opinion, but that the effect is likely to be serious no one can doubt. For every barrel of oil burned so much less coal is used. One million barrels of oil are equivalent to 250,000 tons of coal, and four million barrels of oil would counterbalance the entire coal output of this State last year. That the price of coal is likely to be seriously affected by the coming in of large amounts of fuel oil is not to be denied, but this will apply chiefly to locomotive coal and to the coal used by the larger establishments which can afford to make the change from the one fuel to the other. Coal for domestic consumption is not likely to be affected so much, for this fuel will continue to be used in private houses, etc. It is not known now what proportion of the coal and lignite mined in the State or brought into it from beyond its borders, goes for domestic consumption, but inasmuch as wood is extensively used and gas to a less extent, the proportion is not likely to be very large. The fixation of freight rates on oil will be of great importance in this matter and, other things being equal, will probably determine a large or a small consumption. Such considerations will eventually adjust themselves and a way will be found for harmonizing the several interests.

Another use to which petroleum is put, and which, of course, is directly connected with its employment as fuel, is in driving engines direct in the so-called oil engines, thus dispensing with the use of steam. The expansive force of vaporized oil is the motive power in these engines and the oil is ignited either by an electric spark, or other suitable device. As early as 1791 the attempt was made by Street to use oil in this manner, and since that time many eminent inventors and mechanicians have worked on the problem, the first to produce a practical engine being Julius Hock, Vienna, 1870. The result now is a practical engine deriving its motive power from the combustion of crude petroleum. It has long since passed the experimental stage, and although there are some problems still to be solved, on the whole it may be said that the crude oil engine has proved itself to be an efficient and economical machine.

Some data with respect to oil engines may not be out of place here, inasmuch as we may well consider every possible means of utilizing petroleum. Gasoline engines are extensively employed in many parts of this country and especially in the more arid regions where water for steam and wood or coal for fuel are scarce. Crude petroleum has been successfully used in a similar manner and it may be that we shall witness before long a great augmentation in the number and capacity of such crude oil engines. There are many localities in Texas and the Southwest where both water and fuel are serious items, and yet where there exists a necessity for some machine that will pump water, run mills, etc., without obliging one to wait on the caprices of the wind. There is offered here the widest field for the introduction of oil engines, dispensing with water, save for cooling the cylinders, and using material which can be depended upon for uniformity and excellence of results. It must, however, be said that the most successful of these engines are using oil of a somewhat less density than Beaumont oil, the specific gravity lying between 0.78 and 0.85. The density, therefore, is nearer that of Corsicana oil.

The following remarks are taken, for the most part, from Dugald Clerk (The Gas and Oil Engine). In 1890, Professor Unwin tested the Priestman oil engine and found that by using a Scotch paraffin oil (obtained by the distillation of oil shale), specific gravity 0.81 and flash point 152° F., the amount of oil consumed, per indicated horse-power per hour, was 1.066 pounds, and per brake horse-power 1,243 pounds. By further experiments with Daylight and Russoline oils on a 5-horse-power Priestman engine he found that the consumption, per brake horse-power per hour, was 0.842 pounds for the former and 0.946 pounds for the latter. The composition of these two oils was as follows:

	Daylight oil, per cent.	Russoline oil, per cent.
Carbon	84.82	85.88
Hydrogen	14.66	14.07
Oxygen	0.52	0.05
	100.00	100.00
Specific gravity	0.7936	0.8235
Flash point	77° F	86° F

The *Hornsby* oil engine, at the Royal Agricultural Show at Cambridge, obtained the first prize over nine competitors. It was of eight-horse power and from start to finish ran without a hitch. But one man was required to attend to it, and during the three days' trial the longest time in starting was nine minutes and the shortest seven minutes. The consumption of oil was reckoned at 0.916 pounds per brake horse power per hour, or one and one-cents per brake horse power, the oil being sold at seven and one-half cents per gallon. The composition of the oil was 85.95 per cent. carbon and 14.05 per cent. hydrogen, specific gravity 0.824, and flash point 88° F. A strong point in favor of the use of oil for such purposes developed during the trial and that was the uniformity of composition. A year before this oil had been analyzed and found to contain 14.07 per cent. hydrogen. It is not likely that any ordinary solid fuel would have shown results so closely accordant at an interval of twelve months. The list of oil engines that have shown themselves to be efficient and economical might be extended to include the Robey, the Crossley, the Tangye, the Fielding and Platt, the Campbell, the Clarke, Chapman & Co., Wells Bros., the Daimler (for automobiles), the Stanley (for automobiles), etc. The kind of oil used is lighter than Beaumont oil but similar to Corsicana oil, as has already been observed. Here is a field of almost limitless extent for the exploitation of Texas oil and one that is now being cultivated elsewhere and with oils not dissimilar to ours with great success. While crude Beaumont oil is, perhaps, too heavy for such purposes, yet the oils that can be distilled from it would be well adapted for oil engines, and a great part of the Corsicana oil would be suitable for such use without distillation.

AS A TOP DRESSING FOR STREETS AND ROADS.

On dusty streets and roads, and especially along railroad tracks, the use of crude petroleum has been found advantageous. In California and along the line of the Southern Pacific Railway it has been used for several years, and there has been more or less experience with it in Corsicana and Waco, Texas.

The surface should be well prepared, with whatever slope is adopted by the engineers, and the oil should be applied *hot* at the rate of 100 to 180 barrels per mile for an 18-foot roadway, 60 to 100 barrels at the first application and 20 to 40 barrels each at two subsequent applications. By this means the dust is effectually laid, but it has been stated that in some cities, at least, the fine dust which is still blown about by the winds carries more or less oil and settles on clothing, etc. In getting into or out of vehicles, if the clothing comes in contact with the tires, as is often the case, there is left a smudge of oil difficult to remove. It is also said that oil-covered roadways are injurious to rubber tires, especially to pneumatic tires. Perhaps each locality has had its own peculiar experience with oil-covered roads and streets. In some places they have been found to be a great improvement over former conditions, in others the improvement, while perceptible, has not been so pronounced, and in others the general sentiment of the community can not be said to favor them. The preparation of the surface, previous to the application of the oil, is of the greatest importance, for if this be improperly or ineffectually done the best results can not be anticipated. It is with this as with most other things, if it be properly done, with due regard to local conditions, the results are of a much better sort than if the work is improperly done. It may be that some of the untoward experiences with oil as a dust preventive have come about through lack of knowledge of the best methods of procedure. To take an ordinary street, without preparing and sloping the surface and providing for proper drainage, treat it with oil, for the most part *cold*, and then expect returns on the investment, is to invite disappointment. It would be interesting to know, if it could be known, what is the yearly depreciation in the value of dry goods, notions, clothing, carpets, draperies, etc., in a city like X. Y. Z., for instance, where the dust is at times like a simoon of the desert. One day it will blow up the streets, the next day what has gone up comes back again, and on the third day, for variety, it blows in all directions at once. The only way to get rid of the dust, as fine almost as air, is to put things into an air-tight box and put the box under water. There are many such places in Texas, and any one of them would seem to be a favorable locality for experiments with oil in the laying of dust. But they must be carried on systematically and with due regard to the preparation of the surface, the nature of the dust, and other local conditions. What has been accomplished elsewhere can be done here.

OIL PRODUCTION OF THE WORLD.

Country.	Year.	Production in bbls. of 42 gals.
Russia	1899	66,752,240
United States	1899	57,070,850
Austria-Hungary	1898	2,304,510
Roumania	1899	1,470,000
Sumatra	1899	861,610
India	1898	542,068
Java	1899	350,000
Japan	1898	265,000
Germany	1899	192,232
Italy	1898	14,409
Great Britain	1898	1,900
Grand total	....	132,920,900

The production and value of crude petroleum in the United States in 1899 is given by F. H. Oliphant (U. S. Geol. Survey, Div. Min. Res.) as follows, in barrels of forty-two gallons:

	Production, bbls. of 42 gallons.	Value.	
		Total, dollars.	Per bbl.
California	2,642,095	$ 2,506,798	$ 0.95
Colorado	390,278	404,110	1.03
Illinois	360	1,800	5.00
Indiana	3,848,182	3,363,738	0.87
Kansas	69,700	52,275	0.75
Kentucky	18,280	17,256	0.94
Michigan Missouri	132	205	1.55
New York	1,320,909	1,708,980	1.29
Ohio	21,142,108	20,962,904	0.99
Pennsylvania	13,053,603	17,058,410	1.30
Texas	669,013	472,443	0.70
West Virginia	13,910,630	18,014,760	1.29
Wyoming	5,560	38,920	7.00
Grand total	57,070,850	$ 64,603,904	$ 1.13

In addition 13,578 barrels were produced in Kentucky and Tennessee for which no value was given, none being used or sold.

During the year 1899 the exports and values from the United States were as under:

	Gallons.	Value.
Crude petroleum	117,958,927	$ 5,867,859
Naphtha	17,904,015	1,357,607
Illuminating oil	734,532,990	49,460,300
Lubricating oil and paraffin	59,329,185	8,344,735
Residuum	21,544,278	655,678
Total	951,094,441	$ 64,962,389

Allowing forty-two gallons to a barrel, the exports were 2,264,344 barrels.

In 1899 there were 159 steamers, tonnage 393,717, and ten sailing vessels, tonnage 11,321, engaged in the general trade. One of the steamers, built in 1899, the *Strombus*, for the Shell Line Co., had a tonnage of 8500.

Of the total exports of crude oil in 1899, France alone took 73 per cent., Spain came next with 8.5 per cent., Mexico next with 7 per cent., Germany took about 3 per cent., while Cuba took almost as much as Germany. France, Spain, Mexico, Germany and Cuba took about 94 per cent. of the total amount of crude oil exported.

The United Kingdom is our best customer for naphthas, taking very nearly one-half of the total exportation, while Germany takes nearly one-third. Europe, including the United Kingdom, takes fifteen-sixteenths of the exported naphtha. The United Kingdom is also our best single customer for illuminating oils, taking 24 per cent., then follow the Netherlands with 19 per cent., Germany with 16 per cent., Belgium with 5.6 per cent., Japan with 4.5 per cent., China with 3 per cent., etc. Europe, including the United Kingdom, takes more than 74 per cent. of the total exports of illuminating oils, North America a little over 2 per cent., South America a little over 4 per cent., Asia about 15 per cent., and Oceania, Africa, etc., the remainder. The exports of illuminating oils to Asiatic countries have fallen off since 1897 from 19.8 per cent. to 15.1 per cent. in 1899, although 48 per cent. of the oil imported into China and 71 per cent. of that imported into Japan comes from this country. The United Kingdom is also our best customer for lubricating oils, taking 39 per cent., Germany following with a little over 12 per cent., Asia and Oceania with 11.5 per cent., France with 9.6 per cent., Belgium with about 7 per cent., and the Netherlands with somewhat less. Europe, including the United Kingdom, takes nearly 80 per cent. of the total exportation of lubricating oil.

Of the 730,214 barrels of residuum exported Europe takes 99 per cent.

Acknowledgments of courtesies received are due to the several oil companies at Beaumont which furnished data; to the Beaumont Engineering Company; to Mr. Trost, photographer, at Port Arthur; to the Southern Oil Co., and J. S. Cullinan, Corsicana; to Mr. Geo. Dullnig, San Antonio, and to Hon. O. W. Williams, Fort Stockton.

ANNOUNCEMENT.

The University of Texas Mineral Survey is prepared to undertake all kinds of chemical analyses, assays, etc. A list of charges may be obtained on application to the Survey and they will be found to be in harmony with similar fees charged by the leading firms in the country.

In particular, the laboratory is fitted up for all kinds of investigations on oils, with reference to their refining qualities and their value as fuel.

The fees are payable in advance, and all communications should be addressed to

DR. WILLIAM B. PHILLIPS,
The University of Texas Mineral Survey,
Austin, Texas.

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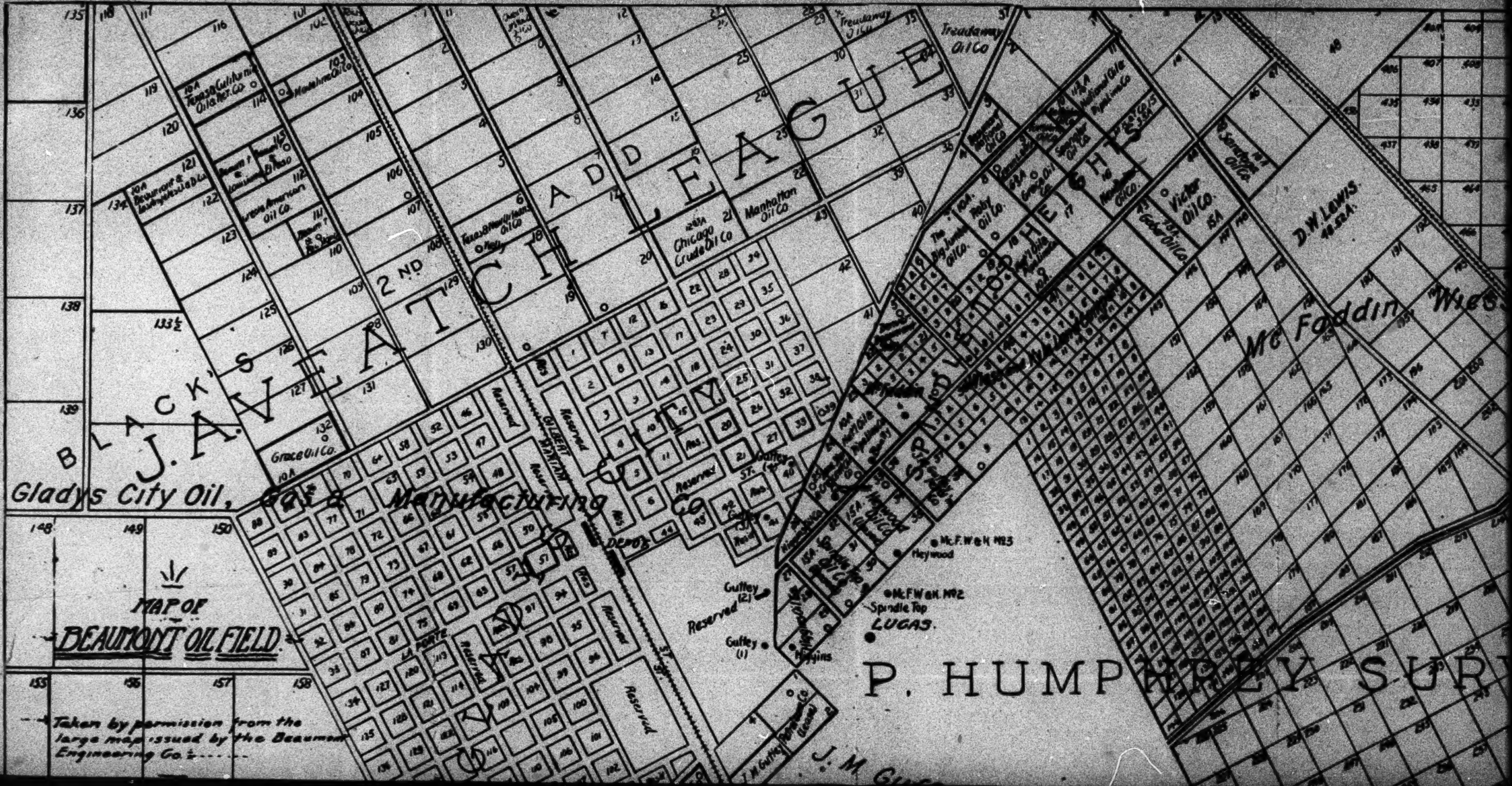
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J. M. Guffey
D. W. Lewis
Treadaway Oil Co
Texas & California Oil & Pet. Co.
Madeline Oil Co
Beaumont & Washington Oil Co
Texas American Oil Co.
Texas & North Western Oil Co
Chicago Crude Oil Co
Manhattan Oil Co
Grace Oil Co.
Beaumont National Oil Co
Poly Oil Co.
Victor Oil Co.
Sanger Oil Co
National Oil Pipeline Co
The Big Jumbo Oil Co.
Gilbert Hanlan
Reserved
Depot
La Porte
McF. W. & K. No 3
Heywood
McF. W. & K. No 2
Spindle Top
LUCAS
Guffey (1)
Guffey (2)
Higgins
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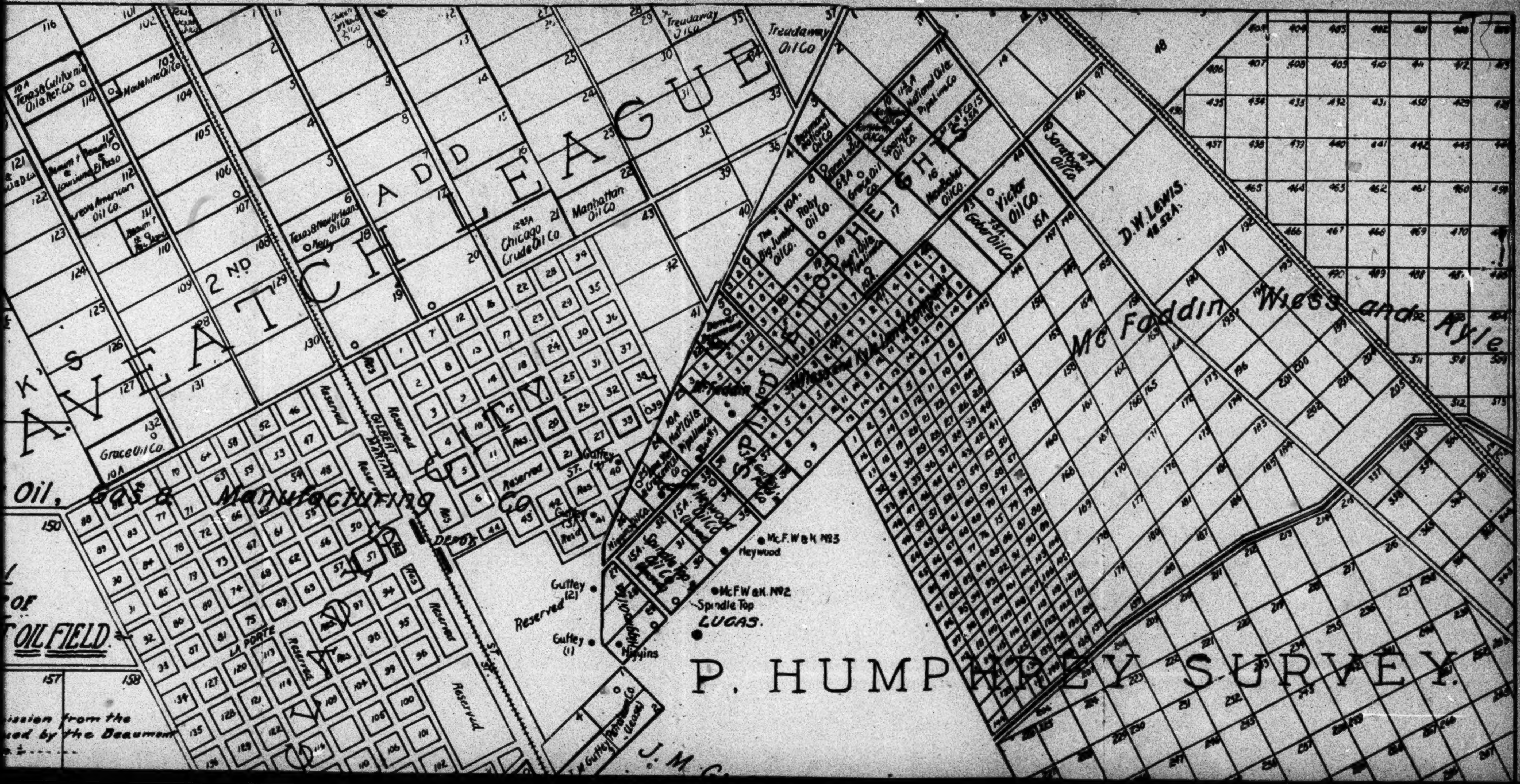

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Texas American Oil Co.
Texas & New Orleans Oil Co
Chicago Crude Oil Co
Manhattan Oil Co
Treadaway Oil Co
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Oil, Gas & Manufacturing Co
GLADYS CITY
SPINDLE TOP HEIGHTS
Beaumont National Oil Co
National Oil & Pipe Line Co
Spangler Oil Co
Roby Oil Co
The Big Jumbo Oil Co.
Victor Oil Co
Saratoga Oil Co
Gaber Oil Co.
D.W. Lewis 48.52 A.
McFaddin, Wiess and Kyle
Heywood Oil Co
Spindle Top Oil Co
Higgins
Guffey (1)
Guffey (2)
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McF.W.&K. No2
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OIL FIELD
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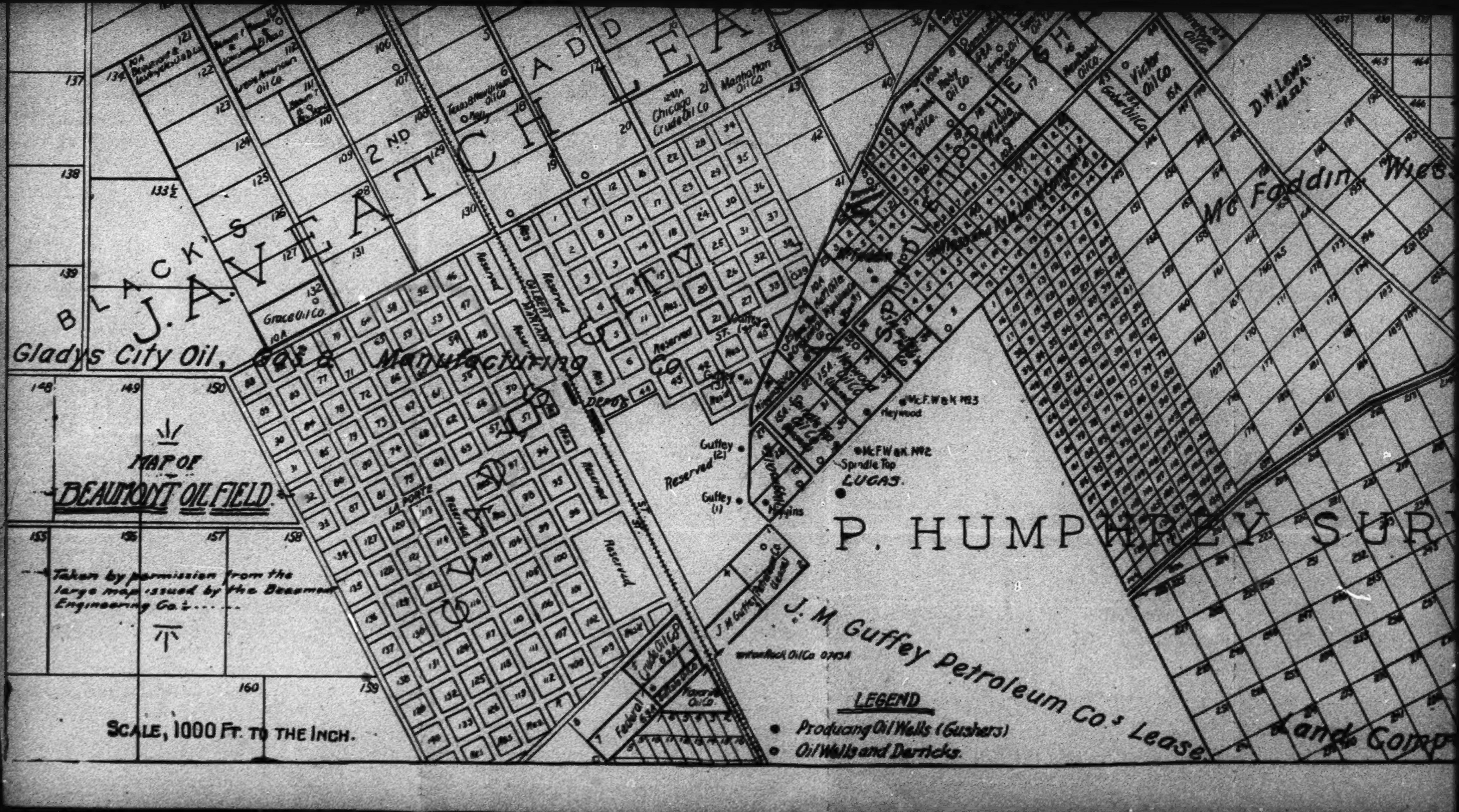
MAP OF
BEAUMONT OIL FIELD
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LEGEND
● Producing Oil Wells (Gushers)
○ Oil Wells and Derricks.
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J. M. Guffey Petroleum Co.s Lease
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Land Comp
D. W. Lewis
Victor Oil Co.
Chicago Crude Oil Co.
Manhattan Oil Co.
Grace Oil Co.
Texas & New Orleans Oil Co.
Federal Crude Oil Co.
LUCAS
Spindle Top
Guffey (1)
Guffey (2)
Higgins
Heywood
McF. W. & K. No. 2
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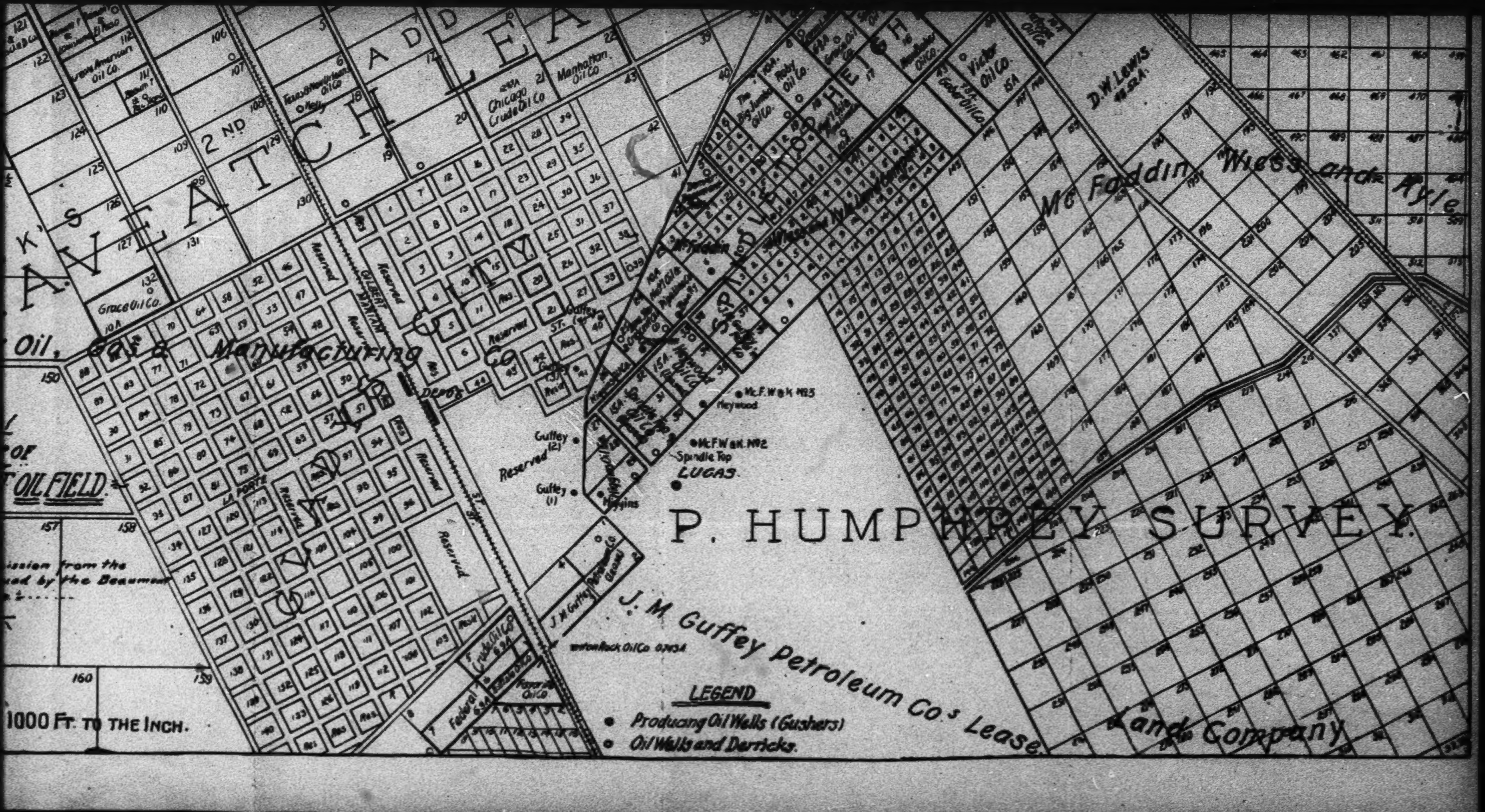
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Guffey (2)
Guffey (1)
Higgins
Heywood
McF.W.& K. No.3
McF.W.& K. No.2
Spindle Top
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J. M. Guffey Petroleum Co.s Lease
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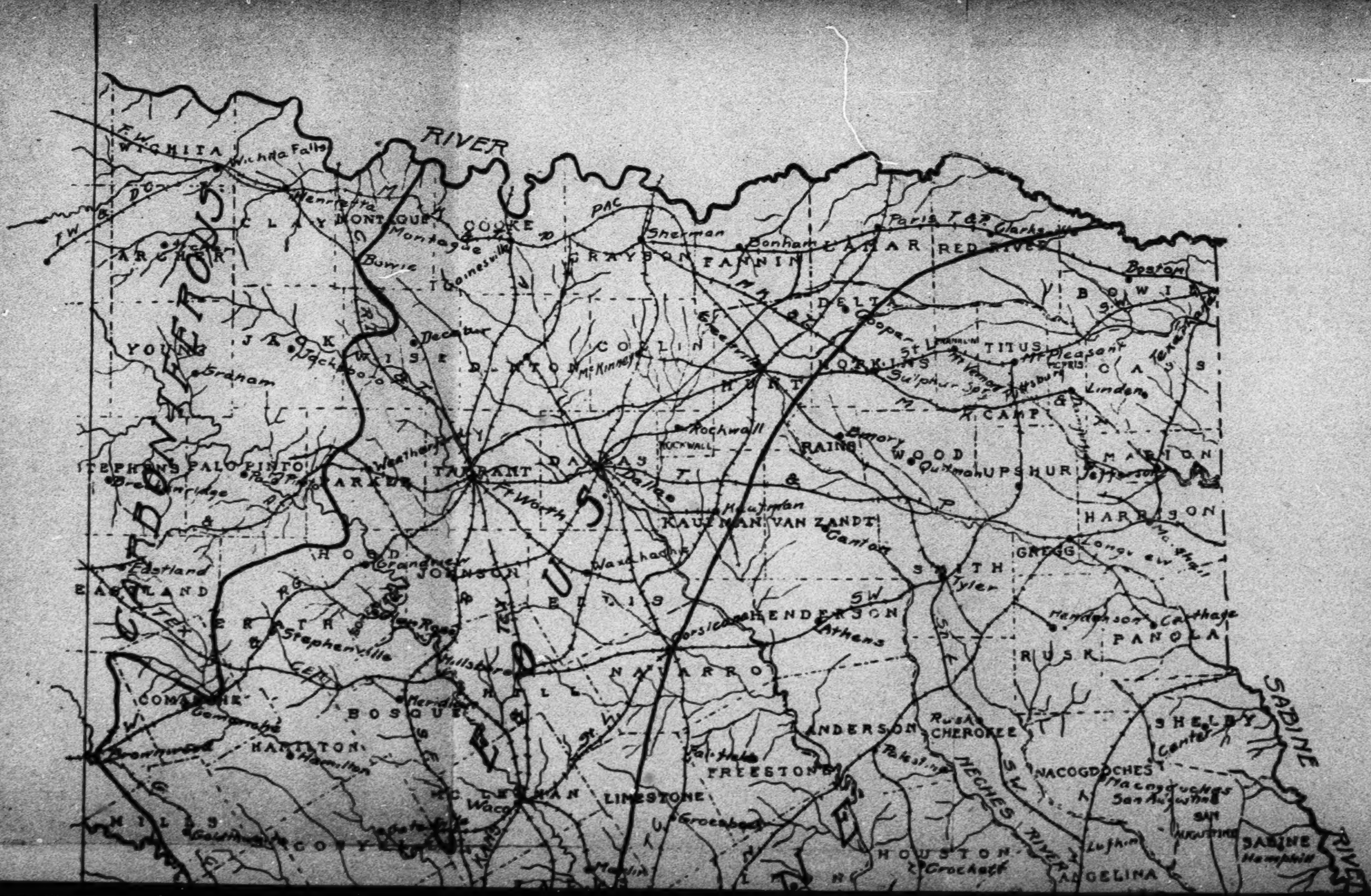
LEGEND
● Producing Oil Wells (Gushers)
○ Oil Wells and Derricks


RIVER
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COOKE
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Decatur
DENTON
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McKinney
ROCKWALL
Rockwall
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MARION
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PANOLA
COMANCHE
Comanche
BOSQUE
Meridian
HAMILTON
Hamilton
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ANDERSON
Palestine
CHEROKEE
Rusk
SHELBY
Center
NACOGDOCHES
Nacogdoches
San Augustine
SAN AUGUSTINE
SABINE
Hemphill
FREESTONE
Fairfield
LIMESTONE
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McLENNAN
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HOUSTON
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Lufkin
ANGELINA
SABINE
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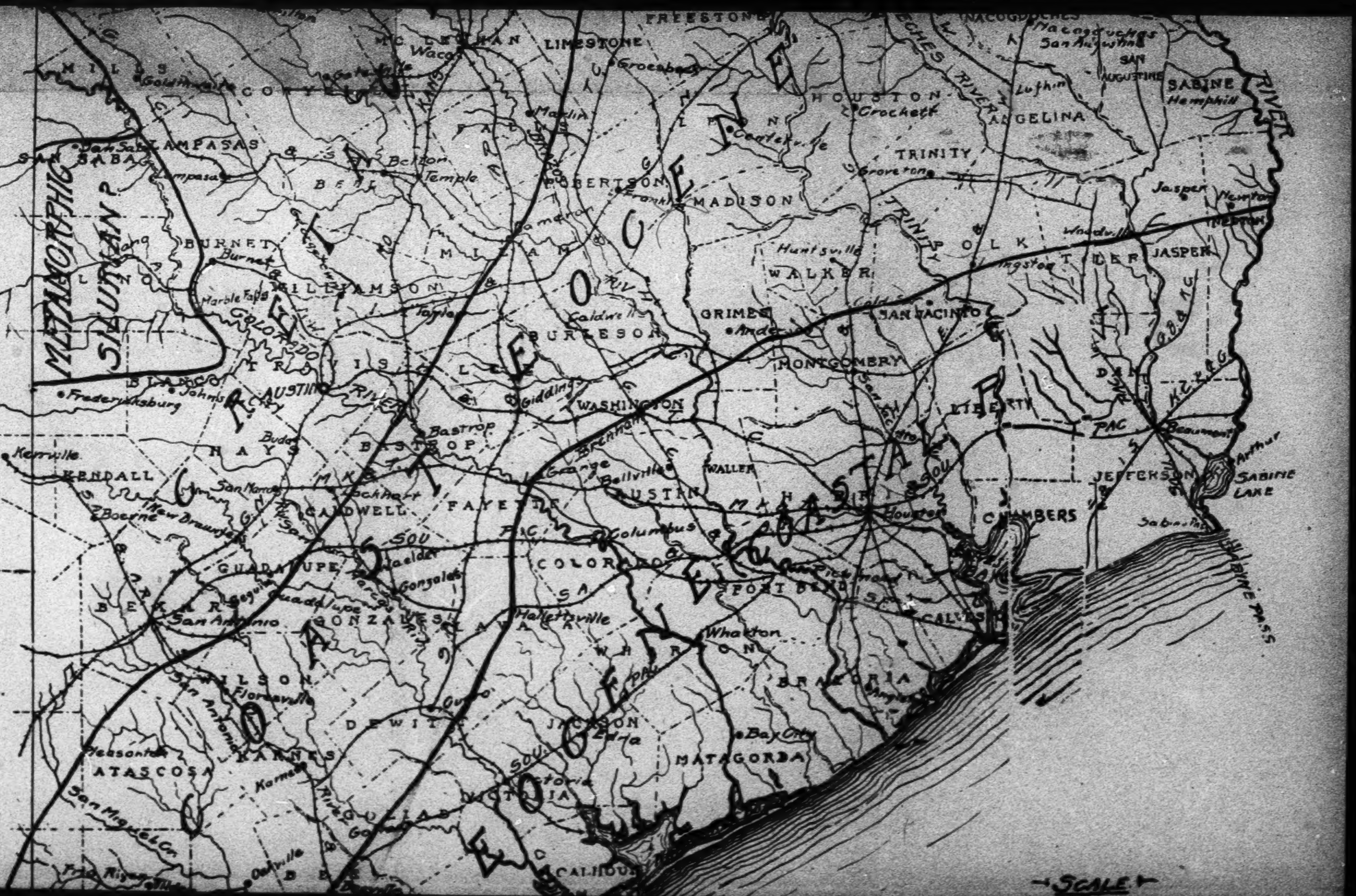
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Marlin
FALLS
NACOGDOCHES
Nacogdoches
San Augustine
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SABINE
Hemphill
Lufkin
HOUSTON
Crockett
ANGELINA
LEON
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TRINITY
Groveton
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Belton
Temple
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ROBERTSON
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Karnes
MATAGORDA
San Miguel Cr.
VICTORIA
Victoria
GOLIAD
Goliad
Frio River
Oakville
BEE
Beeville
CALHOUN
COLORADO RIVER
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NECHES RIVER
SABINE RIVER
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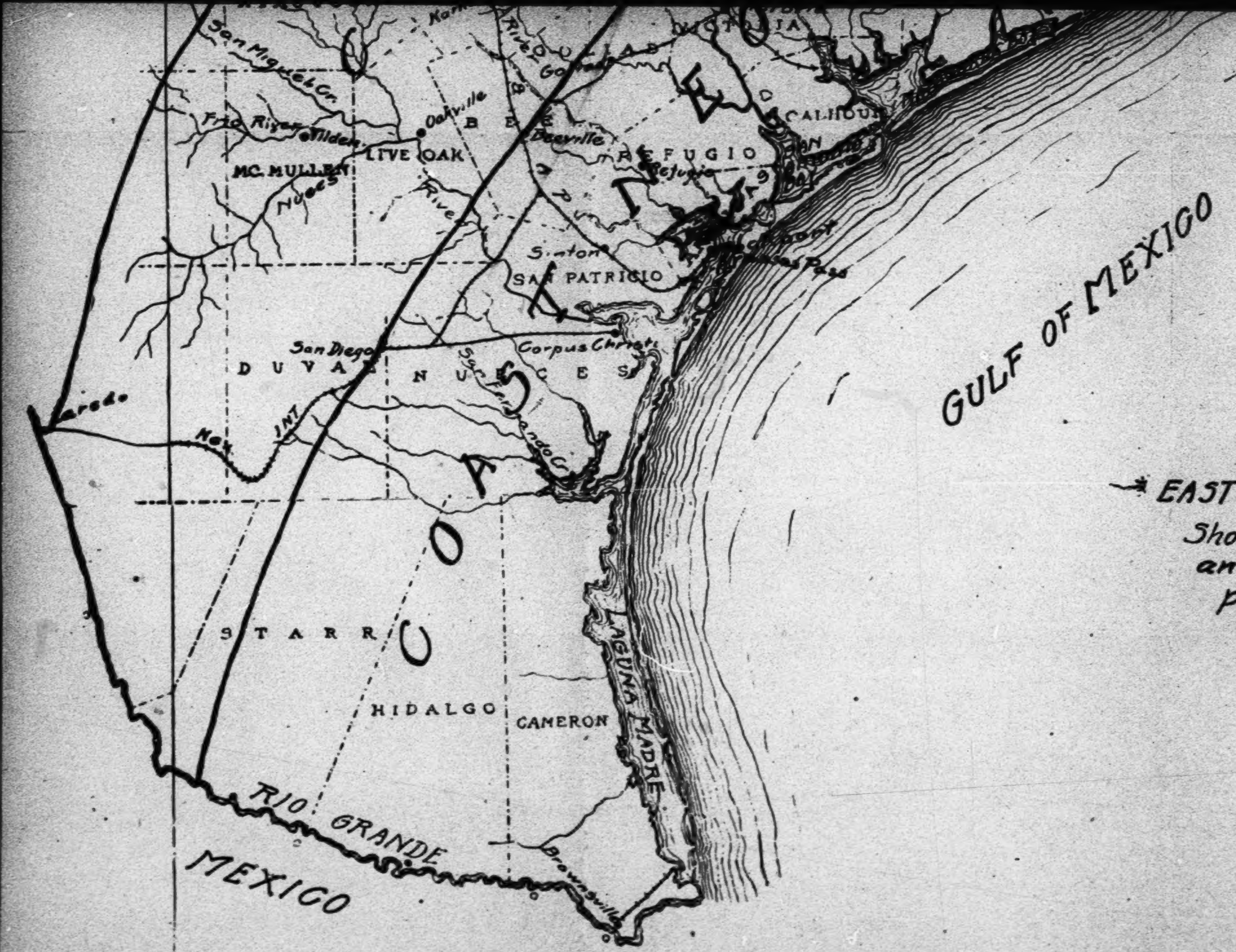
San Miguel Cr.
Frio River
Dilden
Oakville
Live Oak
MC. MULLEN
LIVE OAK
BEE
Beeville
GOLIAD
Goliad
VICTORIA
CALHOUN
REFUGIO
Refugio
Nueces
River
Sinton
SAN PATRICIO
Aransas Pass
Corpus Christi
San Diego
DUVAL
NUECES
San Fernando Cr.
Laredo
Mex. INT.
COAST
STARR
HIDALGO
CAMERON
LAGUNA MADRE
Brownsville
RIO GRANDE
MEXICO
GULF OF MEXICO
SCALE
1 in. = 25 m's

MAP OF
TEXAS
EAST OF 99th MERIDIAN

Showing the Coast Eocene
and Neocene and a
part of the Cretaceous
Carboniferous and
Metamorphic.

From

U.S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT
DIRECTOR

THE UNIVERSITY OF TEXAS MINERAL SURVEY
WILLIAM B. PHILLIPS
DIRECTOR

E. M. Douglas, Geographer in charge.
Triangulation by Arthur Stiles.
Topography by Arthur Stiles and Fred. Mc Laughlin.
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